NAVSHIPS 92835

TECHNICAL MANUAL

for

RADIO RECEIVING SET AN/FRR-31

CONSISTING OF

RADIO RECEIVER R777/FRR-31 AND ACCESSORIES

COMMUNICATIONS COMPANY, INC.

CORAL GABLES, FLORIDA

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From: Chief, Bureau of Ships
To: All Activities concerned with the Installation, Operation, and Maintenance of the Subject Equipment

Subj: Technical Manual for Radio Receiving Set AN/FRR-31 NAVSHIPS 92835

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A. G. MUMMA
Chief of Bureau

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INSTALLATION RECORD

Contract Number NObsr-52715 Date of Contract, June 29, 1951

Serial Number of Equipment.....

Date of Acceptance by the Navy.....

Date of Delivery to Contract Destination.....

Date of Completion of Installation.....

Date Placed in Service.....

ORDERING PARTS

All requests for replacement material should include the following data:

1. Standard Navy Stock Number or, when ordering from a Marine Corps or Signal Corps supply depot, the Signal Corps stock number.
2. Name and short description of part.

If the appropriate Standard Navy Stock Number is not available, the following shall be specified:

1. Equipment model or type designation, circuit symbol, and item number.
2. Name of part and complete description.
3. Manufacturer's designation.
4. Contractor's drawing and part number.
5. JAN or Navy type number.

SAFETY NOTICE

The attention of officers and operating personnel is directed to Chapter 67 of Bureau of Ships Manual or superseding instructions on the subject of "Radio-Safety Precautions to be Observed."

This equipment employs voltages which are dangerous, and which may be fatal if contacted by operating personnel. Extreme caution should be exercised when working with the equipment.

While every practical safety precaution has been incorporated in this equipment the following rules must be strictly observed:

KEEP AWAY FROM LIVE CIRCUITS:

Operating personnel must at all times observe all safety regulations. Do not change tubes or make adjustments inside equipment with high voltage supply on. Under certain conditions dangerous potential may exist in circuits with power controls in the off position due to charges retained by capacitors. To avoid casualties always remove power and discharge and ground circuits prior to touching them.

DON'T SERVICE OR ADJUST ALONE:

Under no circumstances should any person reach within or enter the enclosure for the purpose of servicing or adjusting the equipment without the immediate presence or assistance of another person capable of rendering aid.

DON'T TAMPER WITH INTERLOCKS:

Do not depend upon door switches or interlocks for protection but always shut down motor generators or other equipment. Under no circumstances should any access gate, door of safety interlock switch be removed, short circuited, or tampered with in any way, by other than authorized maintenance personnel, nor should reliance be placed upon the interlock switches for removing voltages from the equipment.

AN/FRR-31

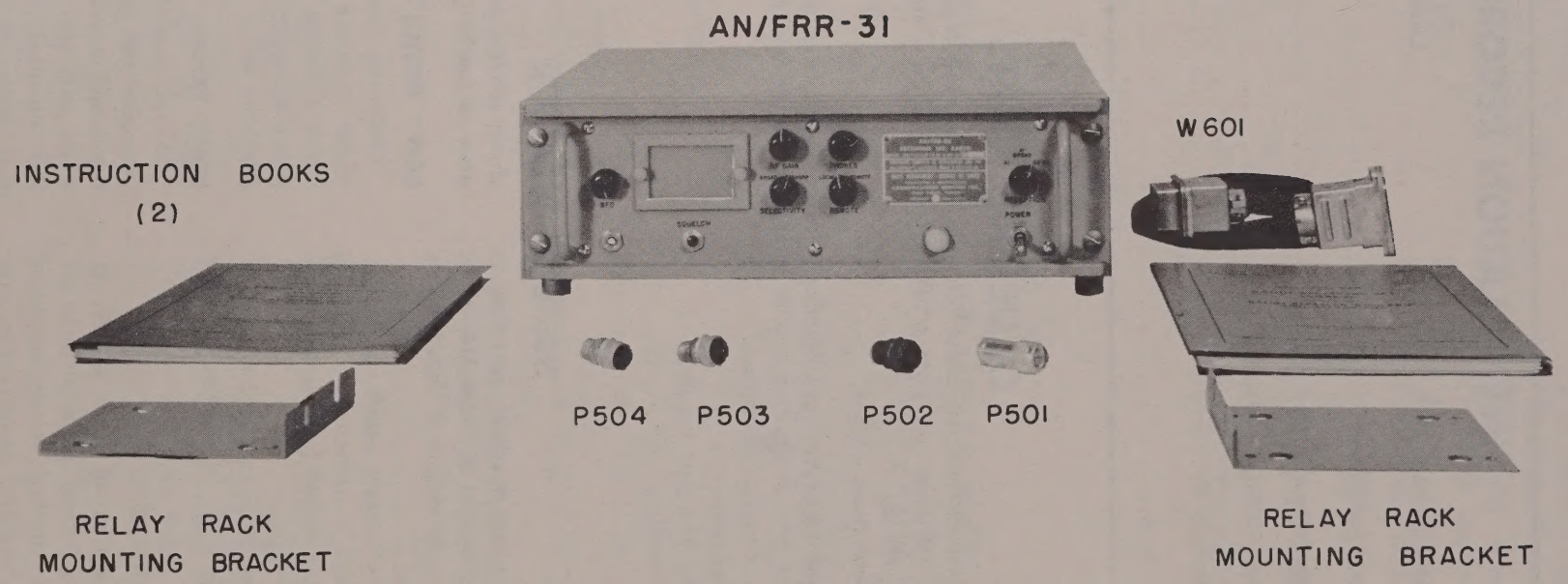


Figure 1-1. Radio Receiving Set AN/FRR-31 Complete, Including Radio Receiver R-777/FRR-31 Brackets, Plugs, Test Cable, and Instruction Books

SECTION 1
GENERAL DESCRIPTION

1. INTRODUCTION.

This instruction book describes the circuit theory, installation, operation and maintenance of Radio Receiving Set AN/FRR-31.

2. DESCRIPTION.

a. PURPOSE.—Radio Receiver Set AN/FRR-31 is designed to provide means for reception of telegraphy, without the use of modulating audio frequencies in the A1 and A1 BROAD positions; telegraphy by the keying of modulating audio frequencies and telephony in the A2-A3 position of operation over a 8-32 Mc. frequency range. It is designed for use in air traffic control towers at Naval Air Stations. The receiver can also be used at Naval Shore Stations or advanced bases on point to point communication circuits. The AN/FRR-31 is designed for both local and limited remote operation and is capable of continuous operation over long periods of time.

b. BASIC PRINCIPLES OF OPERATION.—Radio Receiver Set AN/FRR-31 is a high frequency, double conversion superheterodyne receiver, designed for single channel, crystal controlled operation over a frequency range of 8-32 Mc. A frequency band switch, which is accessible from the rear of the RF chassis only after the receiver has been removed from the case, is employed for the selection of band I, 8-16 Mc.; band II, 16-24 Mc.; band III, 24-32 Mc. when used in conjunction with the proper frequency determining crystal. A RECEPTION switch is employed to allow the selection of the desired mode of reception. This switch allows the selection of either A1, A1 BROAD or the A2-A3 mode of reception. The receiver selectivity is determined by the BROAD-SHARP SELECTIVITY switch position.

The receiver has an overall sensitivity of approximately 1-8 microvolts depending on the mode of reception and the selectivity position. The channel determining oscillator output mixing with the incoming signal provides a 2020 Kc signal, which in turn is mixed with the output of a 1900 Kc oscillator providing an IF of 120 Kc. The BFO control functions to vary the frequency of the beat frequency oscillator, adjusting the pitch of the audio beat note when the set is operating for A1 reception. The BFO circuits are inoperative for A2-A3 reception.

Automatic gain control is applied to the RF amplifier, first and second mixer, and the first 120 Kc IF amplifier when the set is operated for A2-A3 reception, to assure a constant audio output level. A noise limiter circuit permits rejection of a large part of any impulse noise received with signals and may be switched ON or OFF. An adjustable squelch circuit provides noise quieting during A2-A3 reception at times when no signal is being received. When the control is set at maximum, the signal required to open the squelch is in excess of 100 microvolts. The squelch, when set at the most sensitive point, will open with signal inputs at least six db below the actual receiver sensitivity. A 1000 cycle filter is incorporated in the A1 circuit for increased selectivity. The audio limiter holds the audio level within three db over a large range of antenna input voltages.

Connection facilities are provided for remote control of the BFO and the RF gain in the A1 and A1 BROAD positions and the operation of the squelch in the A2-A3 position. Voltage to operate these functions must be supplied from the remote point. Monitoring of the audio signal is possible through the HEAD-TELEPHONE jack.

A three stage audio amplifier, which utilizes inverse feedback, provides output in excess of 1.5 watts with less than seven percent distortion. Audio frequency response is flat within plus or minus two db over a range of 300 to 3500 cycles, and is not down more than ten db at 8000 cps. The use of degeneration permits the varying of loads between 200 and 600 ohms, without a noticeable loss of total audio output. The equipment is designed for local and limited remote operation.

All power necessary for operation of the equipment is obtained from an integral selenium rectifier power supply, which operates from a 105, 115 or 125 volt, 50-60 cycles single phase source. All the audio and power lines are filtered in order to reduce radio frequency interference.

c. EQUIPMENT ARRANGEMENT.—Radio Receiving Set AN/FRR-31 is shown complete in figure 1-1. It consists of the receiver proper (Radio Receiver R-777/FRR-31); a pair of auxiliary angle brackets for relay rack mounting; a set of four mounting legs for table or bench mounting (shown already mounted in place in figure 1-1), a test cable (W601) for connecting the receiver chassis with the rear filter compartment during alignment; four plugs for use in fabricating external cables to the receiver; and two copies of the instruction book.

The receiver proper is designed to permit standardization of case and frame dimensions with other receiver models, and is fabricated to utilize plug-in assemblies.

It consists of a case, at the rear of which is mounted the rear filter compartment; and the panel frame assembly. The panel frame assembly serves as a framework into which three plug-in chassis are inserted (wired completely as functional units) and connects to the front panel shelf through self aligning connectors. The equipment may be mounted on a standard operating table, or in a standard 19" relay rack.

The three plug-in chassis which are designated as the RF chassis, the IF chassis and the Audio/Power Supply chassis, perform basically the functions of their respective titles. Operating controls are mounted on the front panel; and circuit adjustment controls are on the RF, IF and Audio/Power Supply Chassis. All external connections, which includes the antenna transmission line, remote control line, AC power line and the audio line, are brought into the receiver Audio/Power Supply chassis through the rear filter compartment. The antenna is connected from the Audio/Power Supply chassis to the RF chassis by a short coaxial cable and bayonet type connector.

Receiver frequency alignment is accomplished by means of iron core and capacity tuned coils. A special test cable (W601) is supplied with the receiving equipment to permit operation of the receiver outside the case by providing connection between them.

The equipment is supplied with a full complement of tubes and fuses installed. The tube complement is summarized in table 1-4.

3. DESCRIPTION OF MAJOR SUB-ASSEMBLIES.

a. CABINET.—Figure 1-4 shows this unit. It is fabricated from aluminum alloy and finished in gray enamel. Guide rails located at the bottom of the cabinet facilitate removal and replacement of the receiver chassis assembly. When installed in a standard relay rack, the four mounting feet are removed and the two angle brackets are attached to the sides of the cabinet. Spring action side latches on each side of the case permit the receiver chassis to be withdrawn to a point where most of the top chassis components are accessible with the chassis still supported. When it is necessary to remove the chassis from the cabinet, the two latch levers are pressed down and the chassis is withdrawn (see figure 5-2). The receptacle connector (J504) which is visible at the right rear of the case interior is so located that, when the receiver chassis is inserted in the cabinet, the receptacle mates with a corresponding connector on the receiver Audio/Power Supply chassis.

b. REAR COMPARTMENT.—This unit as illustrated in figure 1-3 is permanently mounted to the rear of the receiver case. To obtain access to the compartment, loosen the three Phillips type screws at the rear, and lift off the compartment cover. This unit contains the RF filters and filtering capacitors used in the Audio, Remote and AC lines. It also contains the antenna transmission line. The slant bottom of the compartment mounts the four receptacles (AUDIO, REMOTE, AC POWER and ANTENNA) plus a ground terminal. These comprise all the external connections except the head-telephone jack.

c. PANEL-FRAME ASSEMBLY.—Figures 1-2, 1-5 and 1-6 show this assembly. The panel mounts two handles, which are used to pull the panel-frame assembly from the case and for carrying purposes. Across the top and bottom of the panel are provided blister bars to minimize accidental movement of the panel controls. The panel also has two controls with clutches which must be disengaged prior to removing either the IF or the Audio/Power Supply chassis. The panel and case are finished with gray enamel. The panel mounts a card holder for the frequency chart card and also the identification plate. Four Simmons fasteners, one on each corner of the front panel, lock the panel-frame in place when it is inside the cabinet. Behind the front panel, mounted on a shelf, are three receptacle connectors which engage the plug-in chassis connectors. Twelve threaded standoffs are attached to the frame shelves for use in fastening the plug-in chassis by means of captive screws in the chassis units. A hole in the rear of the frame assembly permits the J504 receptacle of the cabinet assembly to engage the mating connector of the Audio/Power Supply chassis. A smaller hole in the back of the frame assembly allows the slotted shaft of the frequency band switch to be accessible for selection.

d. CHASSIS ASSEMBLIES.—These units as indicated in figure 1-6 are completely wired assembles, designed as plug-in units for quick removal and replacement. End angle brackets, at the front and rear, form handles which facilitate removal and handling. Four mounting standoffs (one at each corner) with captive screws provide means of fastening the units to the panel-frame assembly. The receptacle connector, located at one end, is covered by a plate to avoid contact with voltage carrying wires. All coils and tubes are shielded except V302 which is held down with a tube clamp.

(1) RF CHASSIS.—This unit, shown in figures 1-6, 2-4 and 2-5, contains the following stages: an RF Amplifier (V101), a Channel Determining Oscillator (V102), the First Mixer (V103), the 2020 Kc IF circuits and the 1900 Kc Oscillator (V104). All coils are contained in individual aluminum cans for isolation and reduction of interaction between different parts of the circuits. The RF can tops have frequency calibrations to aid fre-

TABLE 1-1. EQUIPMENT SUPPLIED

QUAN. PER EQUIP.	NAME OF UNIT	NAVY TYPE DESIGNATION	OVERALL DIMENSIONS—INCHES			VOLUME CUBIC INCHES	WEIGHT (LBS.)
			HEIGHT	WIDTH	DEPTH		
1	Radio Receiver, including legs	R-777/FRR-31 (See figure 3-1)	6	17	18¾	1912½	40 lbs.
1	Set of four (4) plugs for external cords (packed in a box)	(See figure 3-1)	3½	3½	1	12¼	5 oz.
1	Pair of relay rack mounting brackets	(See figure 3-1)	5¼	6	1	—	9 oz.
1	Test Cable	W601 (See figure 3-1)	3½	3½	12	147	1 lb., 2 oz.
2	Instruction Books	NAVSHIPS 92835	11½	8¾	½	50	2 lb.

TABLE 1-2. EQUIPMENT REQUIRED BUT NOT SUPPLIED

QUAN. PER EQUIP.	NAME OF UNIT	NAVY TYPE DESIGNATION	REQUIRED USE	REQUIRED CHARACTERISTICS
1	Antenna	See applicable installation drawing	Signal pick-up	72 ohm impedance at the signal frequency
As required	Antenna Transmission Line	See applicable installation drawing	Antenna to Receiver connection	72 ohm surge impedance coaxial
1 each channel	Crystal Unit	JAN type CR-18/U	Crystal control of tuning	Crystal frequency computation (See Section 2 para 2.a(3))
As Required	Power Cable	See applicable installation drawing	Power input from 50 to 60 cps; 105, 115, 125 v AC power source 62 watts	2 wires #18 or larger
As Required	Audio Output Cable	See applicable installation drawing	Audio output connection to speaker, headtelephone or other audio responsive devices	Twisted shielded pair
1	Headphones with cord and plug	Navy Type 49016	Listening	600 ohm impedance
1	Loudspeaker or other Audio Responsive Device	See applicable installation drawing	Listening	200 to 600 ohm impedance
1	Remote Control Unit	See applicable installation drawing	Remote control operation	See SECTION 1, para. 4.d.

TABLE 1-3. SHIPPING DATA

SHIPPING CASE NUMBER	CONTENTS DESIGNATION		OVERALL DIMENSIONS (INCHES)			VOLUME (CUBIC INCHES)	WEIGHT (LBS.)
	NAME	DESIGNATION	HEIGHT	WIDTH	DEPTH		
1	Radio Receiving Set	AN/FRR-31	12	23	26½	7314	88 lbs., 8 oz.

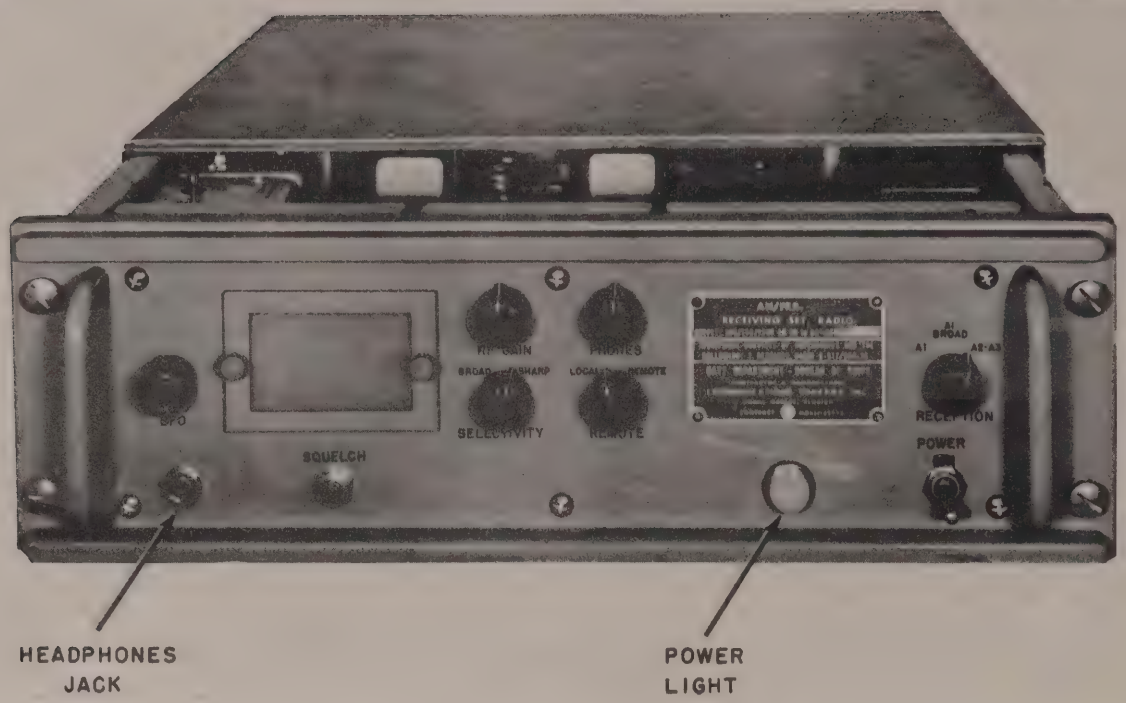


Figure 1-2. AN/FRR-31 Radio Receiver, Front Top View, Unit Slid out of Case

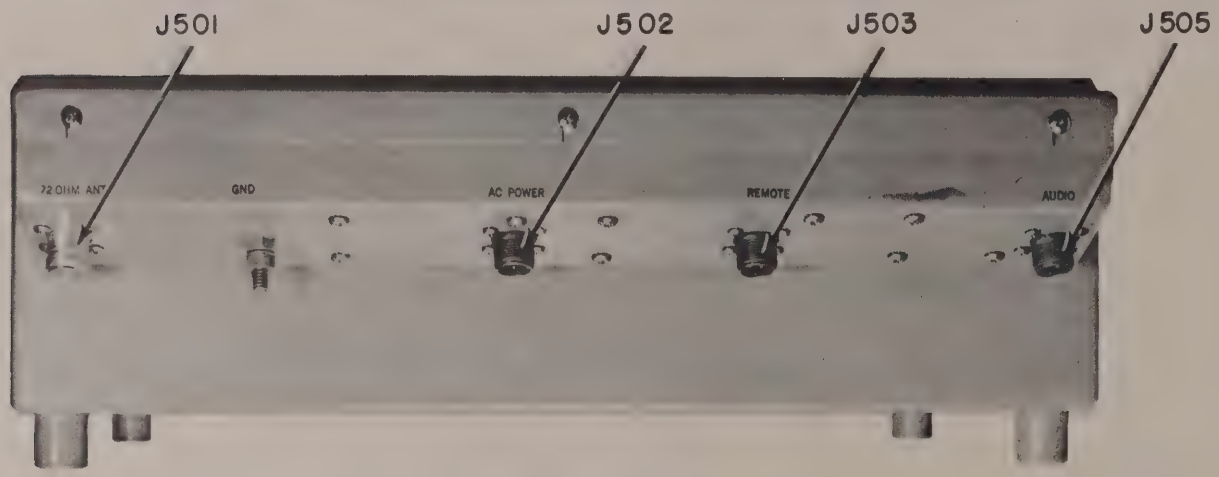


Figure 1-3. Rear View, Radio Receiver, Showing Rear Compartment with Connector Receptacles

quency changing. A small separate sub-chassis, which is mounted slightly higher than the remaining chassis level, mounts the components of the 1900 Kc Oscillator including the crystal, Y102. The 2020 Kc IF transformer slugs must be adjusted from the tops and bottoms of the cans with a special tool which is furnished with the set for the purpose of tuning all IF transformers. This alignment tool is mounted on the end plate of the Audio/Power Supply chassis. A coaxial receptacle on the top of the RF unit is provided for the antenna transmission line from the Audio/Power Supply chassis.

(2) IF CHASSIS.—This unit illustrated in figures 1-6, 2-9 and 2-10, contains the second Mixer (V201), two 120 Kc IF Amplifiers (V202, V203), the Detector-AGC Amplifier (V204), the Beat Frequency Oscillator (V207), the Buffer (V208), the Noise Limiter (V205) and the First Audio Amplifier-Squelch (V206) stages. The transformer coils are slug tuned and four chassis feed-thru terminals provide access to alignment test points. The NOISE LIMITER switch (S202) and SQUELCH control (R217) are accessible from the top of the chassis.

(3) AUDIO/POWER SUPPLY CHASSIS.—This unit is illustrated in figures 1-6, 2-16 and 2-17. A power transformer, a filter choke, and audio transformer and a 1000 cycle filter, all metal cased, are located on the Audio/Power Supply chassis. To the rear of these parts is the connector which mates with that of the rear compartment to provide entrance of all audio, AC power,

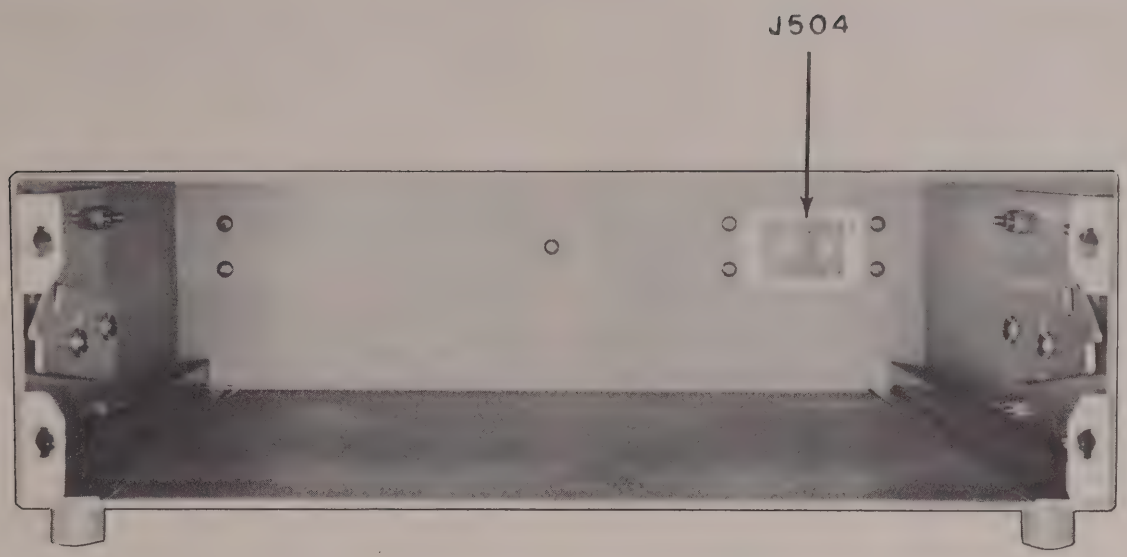


Figure 1-4. View into Cabinet, Inside Case Details

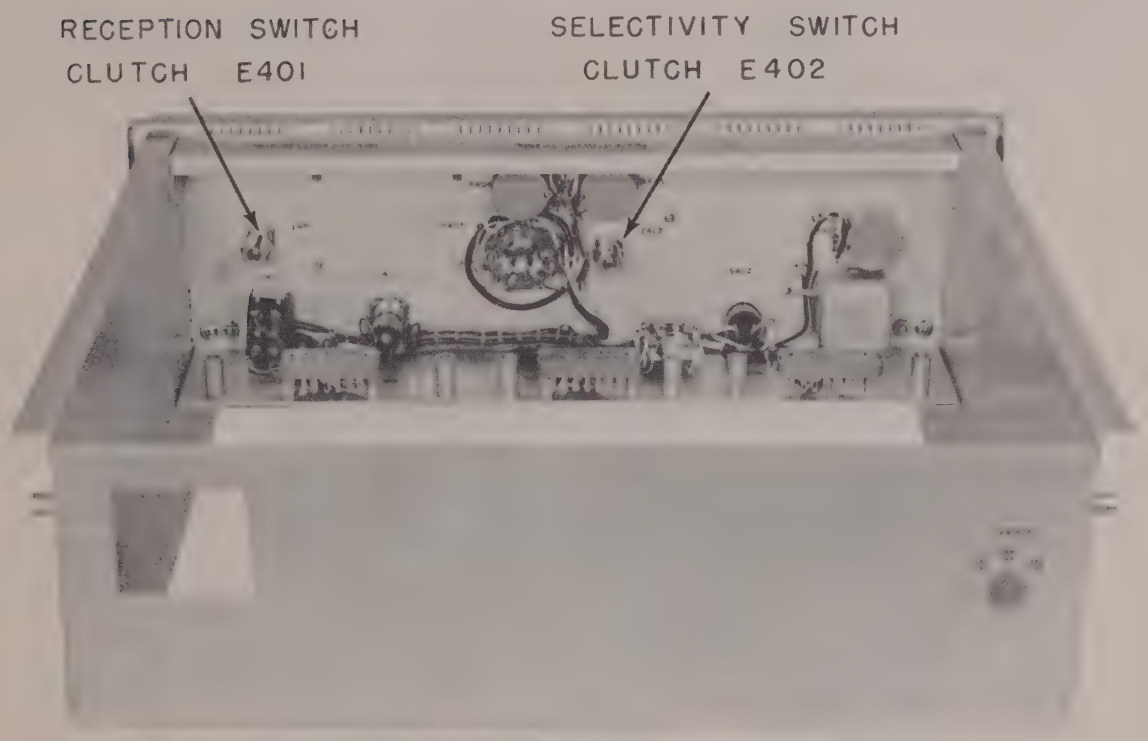


Figure 1-5. Rear View of Front Panel and Wraparound

antenna and remote lines. The AC current is rectified by three selenium rectifiers to furnish B and Bias voltages.

The AF LEVEL control is also located on the top of the chassis (R310 A and B). Two post type fuse holders house the two fuses (F301, F302). A spare fuse is mounted in a clip next to the 1000 cycle filter (FL301).

A jumper coaxial cable, permanently wired to the J302 receptacle, and terminating in a coaxial connector provides coupling to the RF chassis.

4. ASSOCIATED EQUIPMENT.

The components and parts described below are not supplied with the receiver but are required to complete the installation and operation of a type AN/FRR-31 Radio Receiving Set.

a. ANTENNA.—The antenna to be used with this receiver must be designed to have an impedance of approximately 72 ohms, with characteristics which result in optimum matching with the transmission line in the frequency ranges most used. The applicable installation

drawings will indicate the particular type of antenna to be used.

b. ANTENNA TRANSMISSION LINE.—A coaxial transmission line, having a characteristic impedance of about 72 ohms, the diameter of which will permit use with type UG-21B/U plug (supplied with the AN/-FRR-31), is required for connection between the antenna and the receiver. The applicable installation drawings indicate the type to be used for this purpose.

c. PHONES AND SPEAKERS.—The audio circuits available at the REMOTE (J503) and AUDIO (J505) receptacles at the rear of the receiver are designed to operate into any load impedance between 200 and 600 ohms. The output is maintained within two db over this impedance range. This permits numerous combinations of speakers and headphones. A portion of the audio output is available for monitoring at the head-telephone jack on the front panel. This jack (J404) takes a standard two conductor phone plug.

d. REMOTE UNIT.—This unit must have sufficient facilities to supply a variable positive voltage to control the BFO, a variable negative voltage to control RF gain and a momentary switched negative voltage to disable the squelch. See paragraph 2.d. in SECTION 2 and paragraph 5 in SECTION 3 for more information regarding requirements of remote unit.

e. CRYSTALS.—The AN/FRR-31 is designed for operation with a type CR-18/U frequency determining crystal (Y101). One frequency determining oscillator crystal for each channel to be used is required.

The frequency formula to be used is described in SECTION 7 paragraph 4.f. and the crystal unit is illustrated in figure 7-16.

5. REFERENCE INFORMATION.

a. Nomenclature—Radio Receiving Set AN/FRR-31.

b. Contract Number—NObsr-52715 dated 29 June 1951.

c. Contractor—Communications Company, Inc.
300 Greco Avenue
Coral Gables, Florida

d. Cognizant Naval Inspector—Inspector of Naval Material, Room 248
Peachtree—Seventh Building
50 Seventh Street N.E.
Atlanta 23, Georgia

e. Number of Packages—Complete equipment in one wood shipping case.

f. Total Cubical Contents—Crated:—7314 cu in.; Uncrated:—1912.5 cu in.

g. Total Weight—Crated:—88 lbs, 8 ozs.; Uncrated: —44 lbs.

h. Frequency Range—8-32 Mc.

i. Tuning Bands—Three bands: 8-16, 16-24, 24-32 Mc.

j. Number of Pre-set Frequencies—One as determined by crystal Y101, the Channel Determining Oscillator.

k. Type of Frequency Control—Crystal-controlled Oscillator.

l. Type of Modulation—Amplitude Modulated on A2-A3 Reception.

m. Type of Receiver—Double Conversion Superheterodyne.

n. Intermediate Frequency—2020 Kc first IF, and 120 Kc second IF.

o. Receiver Output

(1) Audio Channel Output—At least 1.5 watts into a 200 to 600 ohm load, with less than seven percent distortion.

(2) Phone Jack—At least 15 milliwatts into a 600 ohm load, with less than seven percent distortion.

p. Type of Reception—A1, A2 and A3.

q. Crystals

(1) Type—JAN type CR-18/U Channel Frequency Determining crystal (not supplied by contractor). Frequency range of 6,990 Kc to 14,900 Kc to cover receiver tuning range of 8-32 Mc. Complete frequency computation information is given in SECTION 2, para 2.a.(3).

(2) Type—JAN type CR-18/U, Second Conversion Oscillator Crystal, nominal frequency 1900 Kc.

r. Frequency Stability Data—

(1) Variation in line voltage $\pm 10\%$ of normal does not vary the resonant frequency of the receiver by more than approximately 100 cycles.

(2) Variations in power line frequency from 50 to 60 cycles does not vary the resonant frequency by more than approximately 100 cycles.

(3) Variation in ambient temperature between —15°C (5°F) to +50°C (+122°F) does not vary the resonant frequency of the receiver by more than approximately 200 cycles.

s. Squelch Circuit Characteristics—

(1) Effective Silencing Range—approximately 1 to over 100 microvolts.

(2) Time Constant—Under 0.2 seconds.

t. Impedances—

(1) Antenna Input—72 ohms unbalanced.

(2) Audio Channel Outputs

(*a*) Audio Receptacle (J505)—load can be within a range of 200 to 600 ohms with less than two db variations of audio output.

(*b*) Head-telephone Jack (J504)—Can be used with 600 ohm head-telephone.

u. Antenna Systems—None supplied. An antenna having a 72 ohm terminal impedance is required.

v. Power Source Characteristics—

(1) Voltage—The primary winding of the power transformer is tapped for inputs of 105, 115 and 125 volts; 50 to 60 cycles with provisions for 10% deviation in line voltage.

(2) Current Requirements—0.57 Amp at 115 volts, 50 to 60 cycles.

(3) Power Requirements—62 watts nominal at 115 volts rms.

w. Automatic Gain Control Characteristics—

(1) Audio output for A2-A3 reception is held substantially flat (within less than three db variation) for various antenna inputs from the AGC threshold (which is approximately six microvolts) to inputs of at least 100,000 microvolts.

(2) AGC time constant less than 0.2 second for inputs of up to 500,000 microvolts.

x. Output Limiter Characteristics—The Audio Output Limiter holds the Audio Level constant within a total variation of less than three db for any variation of CW input from the threshold of operation to over two volts input.

y. Beat Frequency Oscillator Characteristics—When the BFO has been properly tuned, signals that are exactly on the desired frequency will produce a zero beat (or near zero beat) on A1 BROAD reception when the BFO control is close to 50% of its maximum rotation. The remote BFO control, when adjusted to supply the same maximum BFO control voltage as the local control, will produce exactly the range of remote BFO adjustment as obtained from the local BFO control. This range of control is approximately ±2000 cycles taken from a position of 50% of maximum rotation.

z. The RF GAIN control is operative only on A1 and A1 BROAD positions of reception. It is used to regulate the overall receiver gain for these modes of reception. It controls the overall receiver gain by applying an adjustable amount of negative voltage to the AGC control bus which is switched from the AGC control source to the RF GAIN control. The RF GAIN control can vary the overall receiver gain in excess of 100 db which permits the reception of strong RF signals well in excess of two volts rms input.

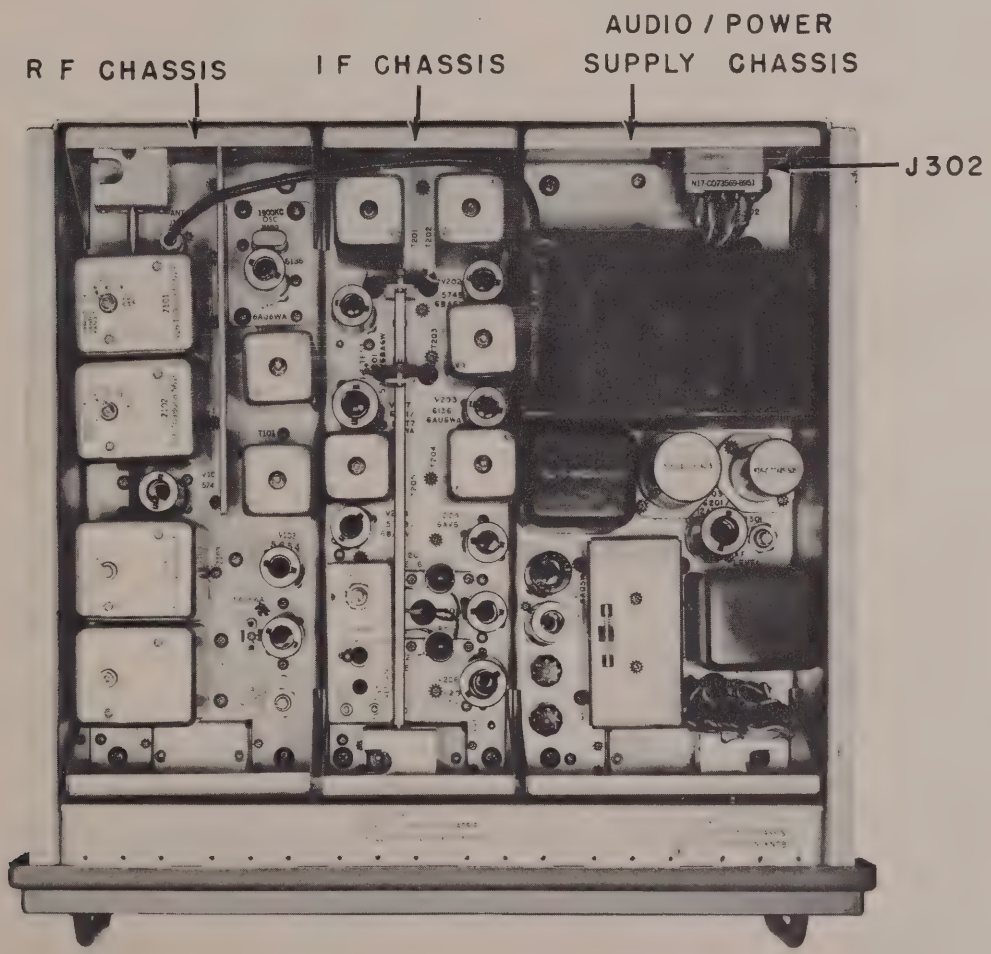


Figure 1-6. Top View of Chassis out of the Case

TABLE 1-4. ELECTRON TUBE COMPLEMENT

CIRCUIT	CIRCUIT SYMBOL	QUANTITIES OF TUBES USED						
		5654/ 6AK5W	5749/ 6BA6W	6136/ 6AU6WA	6AV6	5726/ 6AL5W	6201/ 12AT7WA	6005/ 6AQ5W
RF CHASSIS ASSEMBLY								
RF Amplifier	V101		1					
Channel Det Osc	V102			1				
1st Mixer	V103	1						
1900 Kc Osc	V104			1				
IF CHASSIS ASSEMBLY								
2nd Mixer	V201		1					
1st 120 Kc IF	V202		1					
2nd 120 Kc IF	V203			1				
Det AGC	V204				1			
Noise Limiter	V205A					½		
Squelch Diode	V205B					½		
1st Audio	V206A						½	
Squelch	V206B						½	
BFO Oscillator	V207A						½	
BFO Freq. Control	V207B						½	
Buffer	V208		1					
AUDIO/POWER SUPPLY CHASSIS ASSEMBLY								
2nd AF	V301				1			
Audio Output	V302							1
Audio Limiter	V303						1	

NOTE

When replacing Electron Tubes in this equipment use those listed in the U.S. Navy Reliable Tube List if at all possible, if not select their counterpart as listed by the Armed Services Preferred List of Electron Tubes.

SECTION 2
THEORY OF OPERATION

1. GENERAL PRINCIPLES.

Radio Receiver AN/FRR-31 is a double conversion superheterodyne receiver, designed for single channel crystal controlled operation over a frequency range of 8-32 Mc. tI is provided with means for reception of A1, A2 and A3 signals. Although designed primarily for local operation, circuits are provided for remote control of the RF gain, BFO frequency and Squelch circuit testing.

The Power Supply is designed to operate from a nominal power source of 105, 115 or 125 volts, 50 to 60 cycles AC. The receiver provides an output of at least 1.5 watts from the high level audio connectors, and at least 15 milliwatts from the head-telephone jack with less than seven percent distortion. The front panel controls include: the BFO control which varies the beat frequency $\pm$2000 cycles; the RF GAIN control which can vary the overall receiver gain at least 100 db; the head-telephone jack which provides an audio output of at least 15 milliwatts; the PHONES level control which can vary the head-telephone audio over a range of at least 30 db; the SQUELCH test switch which provides means of disabling the squelch circuit; and the BROAD-SHARP IF selectivity switch. The LOCAL-REMOTE switch disconnects the local RF GAIN control, BFO control and SQUELCH test switch and connects remote facilities, to control these circuits. The RECEPTION switch has three positions: A1, A1 BROAD and A2-A3. The neon lamp indicator shows when the receiver power is ON. Chassis controls include the AF LEVEL control, the NOISE LIMITER switch and the SQUELCH threshold control. The SQUELCH threshold control permits setting the receiver operating threshold at any desired point within a 1 to 100 microvol range as operating conditions warrant. RF filters in the AC power and audio lines prevent signals from entering the receiver through these circuits. The overall block diagram, figure 2-1, indicates the relationship of various circuits in the functioning of the receiver. The incoming signal receives one stage of RF amplification. It is then mixed with the channel determining oscillator output in the mixer and forms the 2020 Kc IF frequency. This is then mixed with the 1900 Kc oscillator output in the second mixer to form a low frequency IF of 120 Kc, which is then amplified in two following stages. The 120 Kc signal is next detected and passes through three stages of audio amplification to the speaker or other loads. For A1 reception, the BFO oscillator's frequency is controlled by the BFO frequency control tube. It is them amplified by the buffer and injected at the detector. The noise limiter, automatic gain control and squelch circuit operate in conjunction with the detector.

Included in the audio amplifier for A1 reception is an audio limiter which permits limiting of the maximum headphone level within the limits of 60 microwatts to at least 15 milliwatts. A 1000 cycle audio filter is incorporated to provide the receiver with additional selectivity for use on A1 reception.

2. DETAILED CIRCUIT DESCRIPTION.

a. RF CHASSIS ASSEMBLY.

(1) ANTENNA INPUT.—The antenna input circuit of the AN/FRR-31 is designed for use with 72 ohm coaxial transmission line, such as JAN type RG-11/U or equivalent. The external transmission line connects to the 72 OHM ANTENNA receptacle (J501) located on the rear compartment of the receiver cabinet. The type UG-21B/U connector plug (P501), for the J501 receptacle, is supplied with the receiver for attachment to the antenna transmission line at the time of installation. A short length of coaxial cable, inside the rear filter compartment, connects the antenna line to the receptacle J504, which is mounted to face the inside of the receiver case. As the receiver chassis slides into the case, the J504 receptacle engages its mating connector (J303) which is mounted at the rear of the Audio/Power Supply chassis assembly. A short length of RG-58A/U coaxial cable, with one end permanently connected to the terminals of J302, terminates at the other end in a bayonet locking plug, AN Type UG-88/U (P301). This plug mates with an AN Type UG-290/U receptacle (J102) on the RF chassis assembly. This arrangement permits removal and replacement of any chassis without unsoldering the antenna connections. J102 then connects to the primaries of the Z101 RF coils. The receiver range of 8 to 32 Mc is divided into three equal bands. Band I: 8 to 16 Mc, and Band II: 16 to 24 Mc; and Band III: 24 to 32 Mc; and for simplicity, figure 2-6

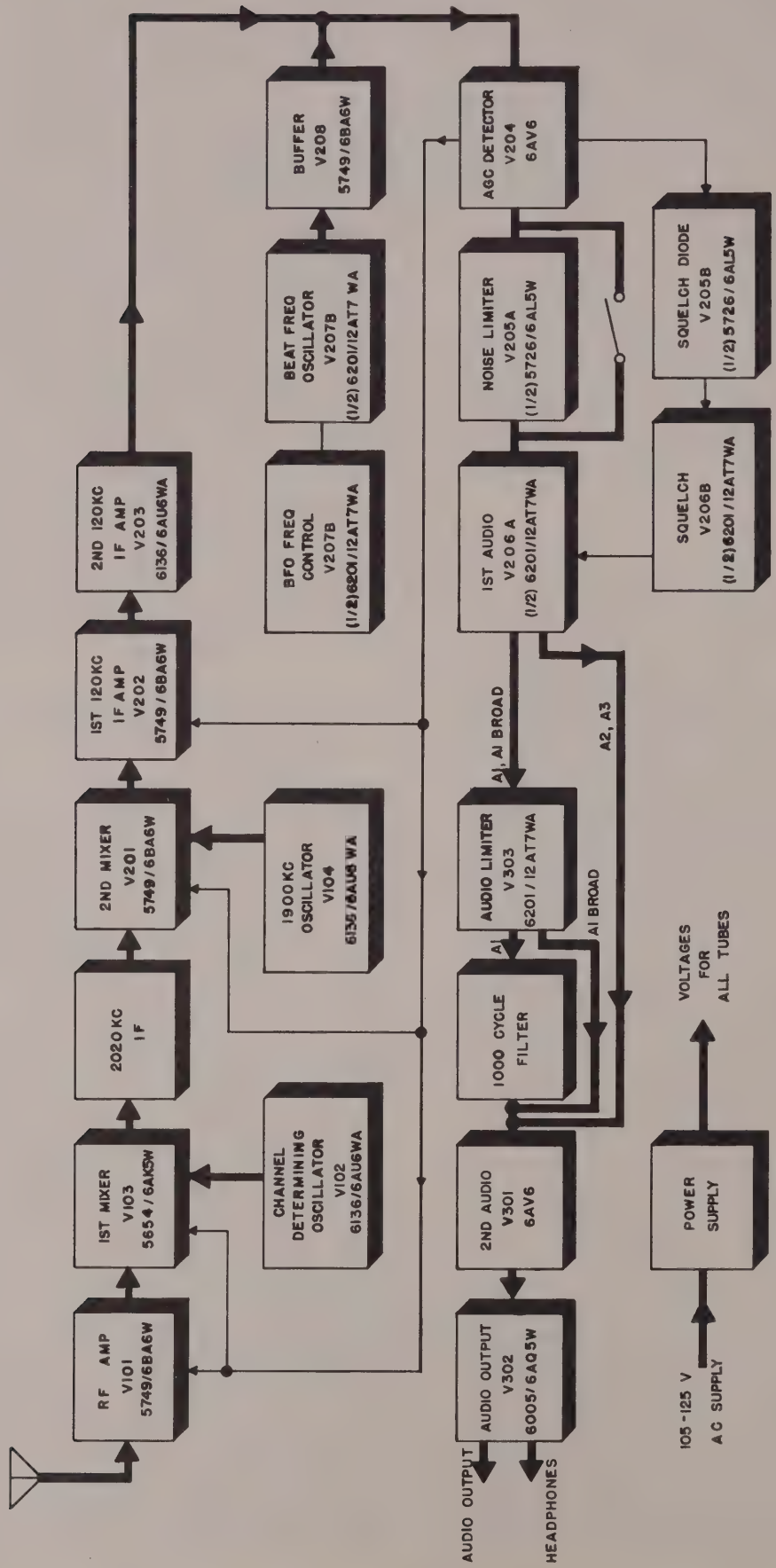


Figure 2-1. Block Diagram for Radio Receiver R-777/FRR-31

Figure 2-2. Front View of the Control Panel

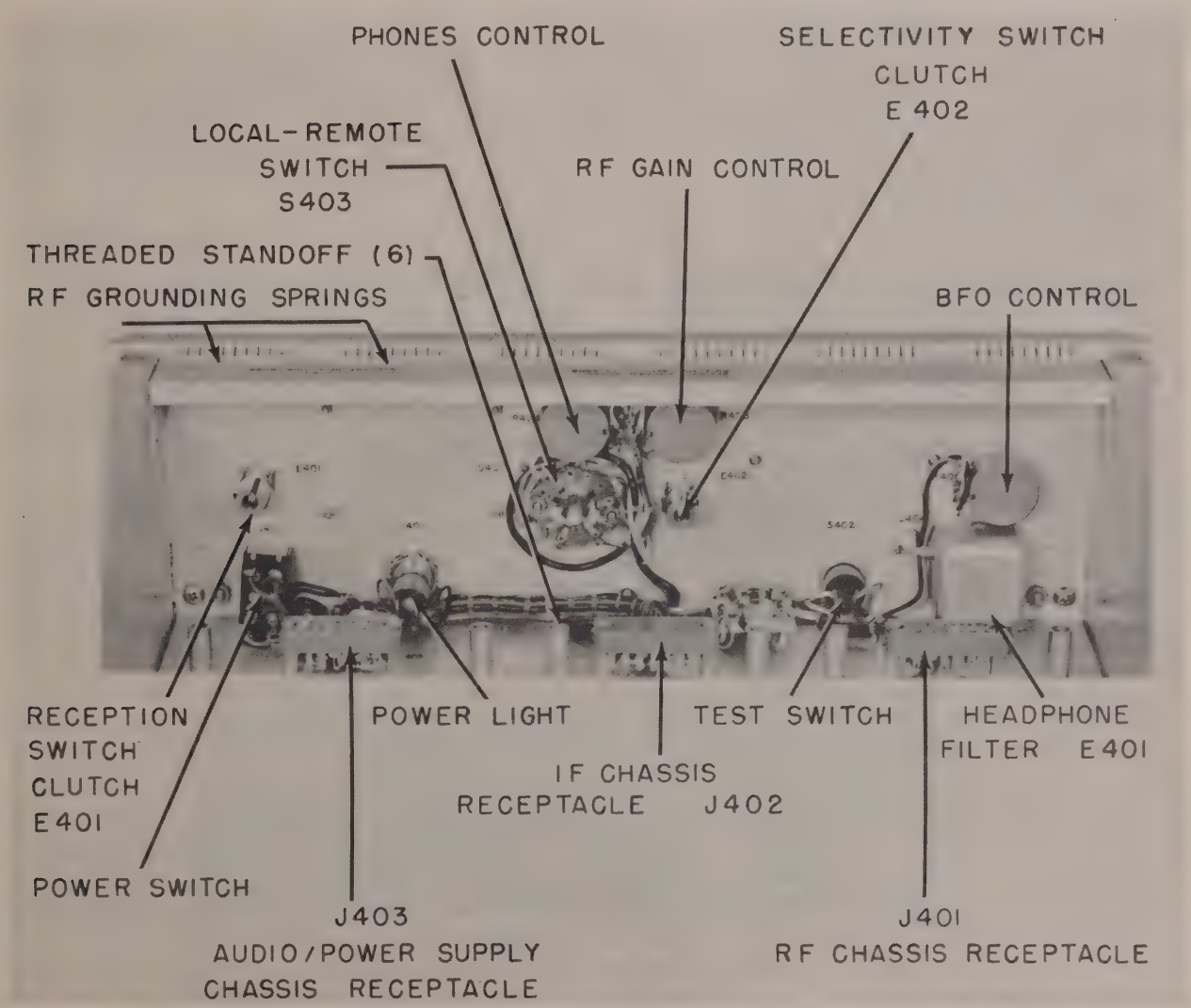


Figure 2-3. Rear View of the Control Panel

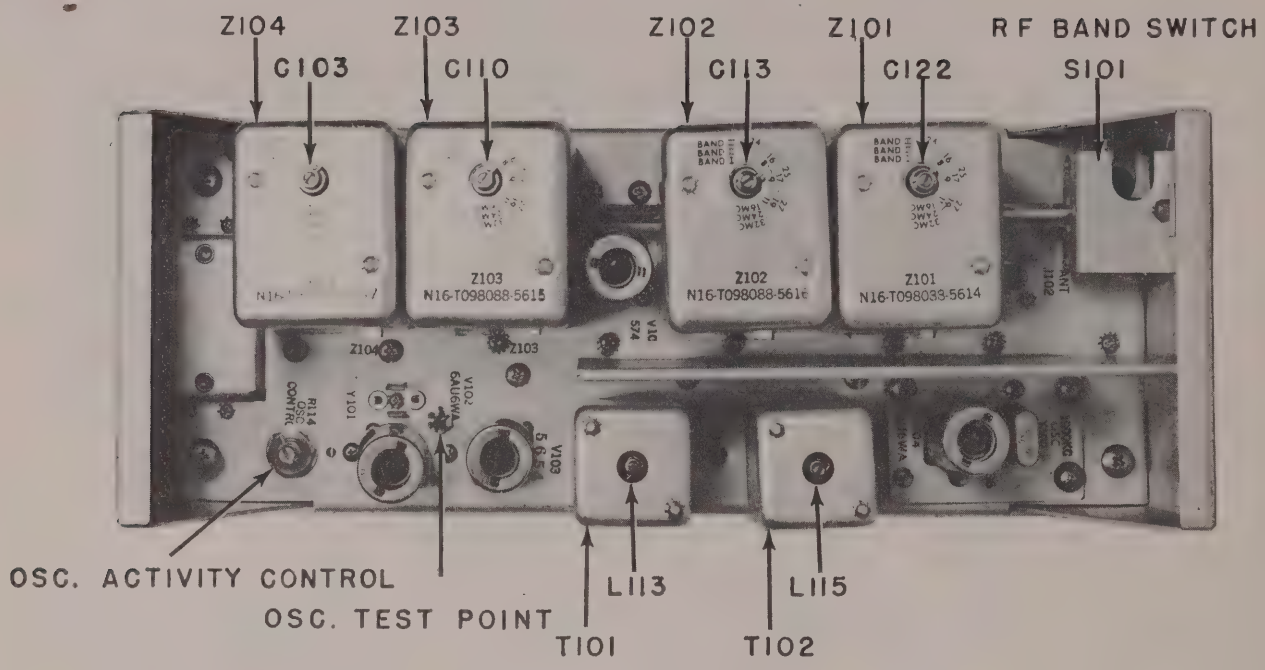


Figure 2-4. Top View of the RF Chassis

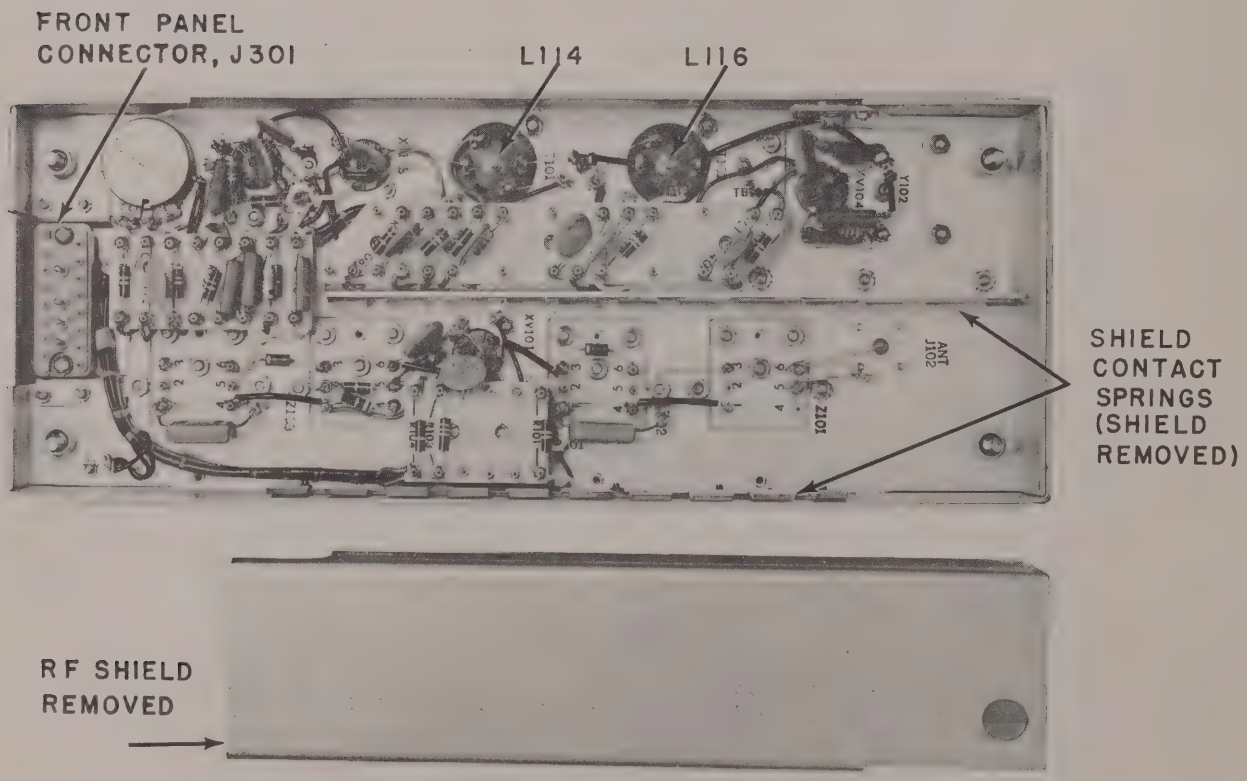


Figure 2-5. Bottom View of the RF Chassis

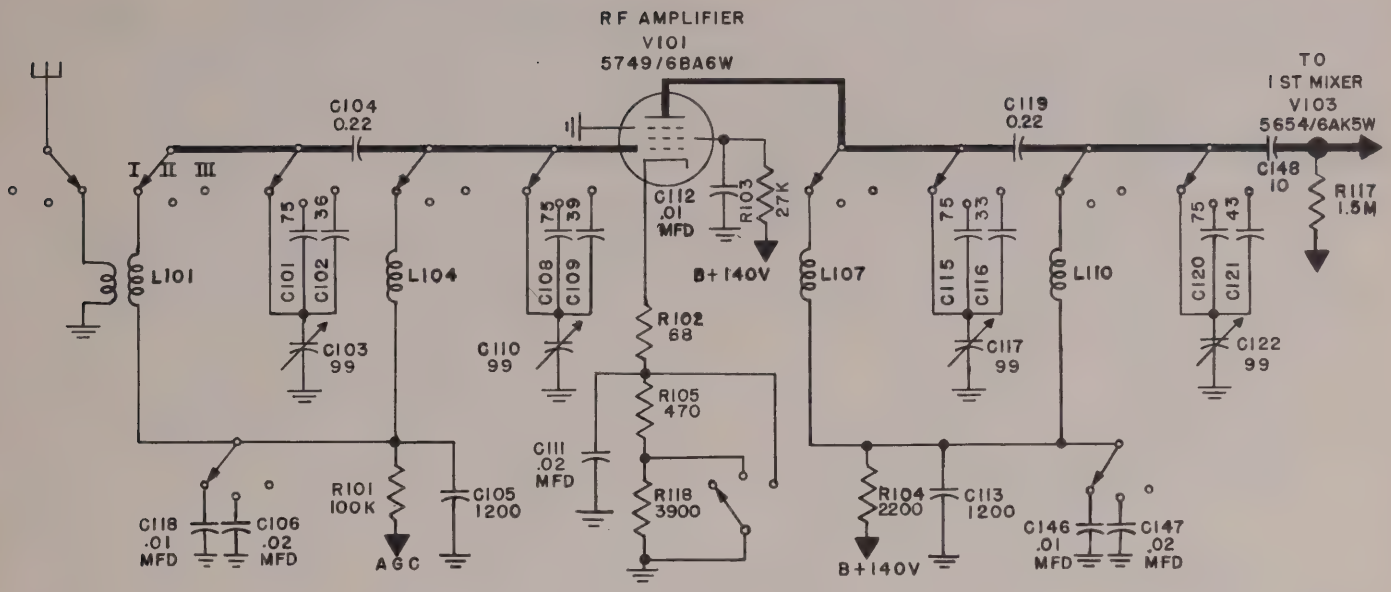


Figure 2-6. Simplified Schematic—RF Amplifier

shows only the coils for Band I with FREQUENCY BAND switch (S101) as being in the Band I position and the discussion will basically concern Band I operation.

(2) RF AMPLIFIER.—As indicated in figure 2-6, the RF amplifier consists of one pentode type 5749/-6BA6W tube (V101) and four shielded RF transformers, each of which has three fixed powdered-iron core coils, one for each band. Each transformer assembly also contains an air dielectric variable capacitor which tunes the coil selected. The four tuned circuits between the antenna input and the first mixer assure adequate selectivity for the rejection of undesired signals near the receiver frequency. The individual shielding prevents interaction between circuits. The first RF transformer (Z101) has six windings; three secondaries, one for each band, and three primaries. The primaries are switched for each band. The receiver input impedance is a nominal 72 ohms.

The signal enters the antenna coil of Z101 and is coupled to L101 which is resonated to the proper frequency by C103. The signal is then coupled to L104 of Z102 by means of coupling capacitor C104 which provides top coupling and by C118 and C105 which provide common bottom coupling. These two means of coupling tend to compensate for gain variations throughout the individual bands. Z102 is resonated to proper frequency by C110. The signal is then applied to the RF amplifier V101 which consists of a type 5749/6BA6W tube. The AGC voltage is applied to V101 through resistor R101, and then L104 to the grid of the RF amplifier. A negative bias of approximately —0.9 volts is applied to this grid from the AGC line, in the absence of a signal, during A2-A3 reception. During A1 or A1 BROAD reception, when the RF GAIN control is at its maximum clockwise position, a negative bias of approximately —0.9 volts is applied to the AGC line. V101 cathode bias is obtained by means of resistors R105 and R118 which are switched for Bands I and II and bypassed by capacitor C111. On all bands, an unbypassed resistor is in the cathode, in order to provide degeneration, in order to practically remove detuning due to "Miller effect". This detuning occurs with the application of AGC or RF gain control voltage to the grid of the RF stage. Screen voltage is obtained from he 140 V B B+ source through voltage dropping resistor R103 to the screen of V101. The screen is bypassed by means of screen bypass capacitor C112. The plate coil L107, of V101, is tuned to the desired frequency by capacitor C117. B+ is supplied to the plate of V101 through isolating resistor R104 which is bypassed by C113. Two means of coupling to Z104 are provided: top coupling by capacitor C119 and bottom common coupling capacitors C113 and C146. L110 of Z104 is tuned to the desired frequency by C122. AGC voltage is not applied to the first mixer V103, which consists of a 5654/6AK5W type tube. The grid is returned to ground through grid resistor R117. B+ voltage is kept from the grid by blocking capacitors C124 and C148. C106 of Z102 and C147 of Z104 are coupled into the circuit only on Band II. The switching of coupling from Band I to Bands II and III is done to obtain the narrowest possible RF band width consistent with the broadest selectivity position of the

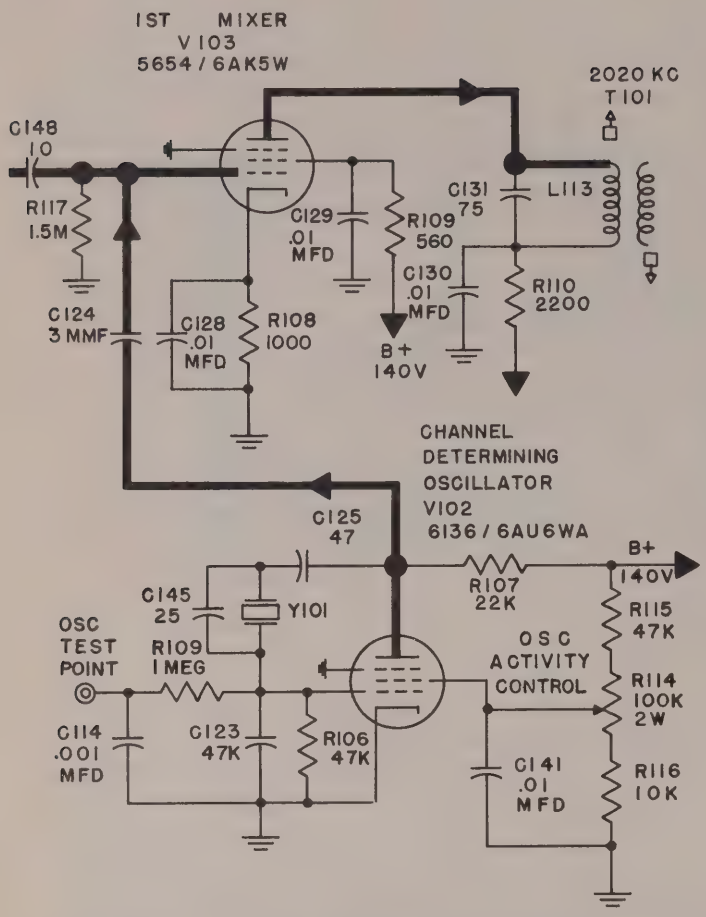


Figure 2-7. Simplified Schematic, 1st Mixer, Channel Determining Oscillator

IF amplifier. When the RF band switch (S101) is changed from Band I to Bands II or III, capacitors are inserted in series with the main tuning capacitors C103, C110, C117 and C122. These additional capacitors provide band spreading to facilitate alignment.

(3) CHANNEL DETERMINING OSCILLATOR.—This portion of the RF chassis assembly determines the frequency of the signal to which the receiver will respond, if the RF circuits are properly resonated. (See Figure 2-7). It consists of a type 6136/6AU6WA pentode (V102) which functions as a Pierce oscillator, having a range of 6,990 Kc to 14,990 Kc. The oscillator must generate an injection frequency which is 2020 Kc higher than the desired channel frequency in the lower half of Band I for all channel frequencies below 12 megacycles and 2020 Kc lower than the desired channel frequencies above 12 megacycles. In Bands II and III, the second harmonic of the crystal is used.

Crystal Computations

Band I: lower half (8-12 Mc); $fx = fs + 2020$ Kc
Band I: upper half (12-16 Mc); $fx = fs - 2020$ Kc
Band II: (16-24 Mc); $fx = fs - \frac{2020 \text{ Kc}}{2}$
Band III: (24-32 Mc); $fx = fs - \frac{2020 \text{ Kc}}{2}$

Mixing this injection with the desired incoming siganl provides a 2020 Kc first IF signal. The channel determining crysatl Y101 is a non-temperature controlled type CR-18/U. This crystal is not supplied with the receiver, as its frequency will depend on the signal frequency to be received. The crystal appears electrically, in resonance, as a high Q parallel L-C circuit. With the proper crystal inserted in the crystal socket XY101, only voltage of crystal frequency is coupled to the grid (pin 1) of V102. This signal is amplified in V102 and appears across plate load resistor R107. This signal is then coupled through B+ blocking capacitor C125, back to the crystal circuit and grid. Capacitor C145, which is across crystal Y101, and the tube capacity form a shunt capacity of 32 $\mu\mu$f for which the crystal is ground. Grid conduction develops grid bias across R106. This can be measured with a vacuum tube voltmeter at this point, but is more convenient to measure at the oscillator test point C114, where it has been filtered by R109 and C114. V102 screen grid voltage is obtained from the voltage divider R115, OSCILLATOR ACTIVITY control R114, and resistor R116. The OSCILLATOR ACTIVITY control is used to adjust the oscillator output injected into the first mixer (V103) to compensate for variances in crystal activity and whether the second harmonic of the crystal is being used. Injection voltage is taken from the plate of the oscillator V102 and coupled through injection capacitor C124 to the grid of the 1st Mixer V103.

(4) FIRST MIXER.—As indicated in figure 2-7, the first mixer (V103) uses a 5654/6AK5W tube to mix the output of the RF amplifier with the output of channel determining oscillator (V102) to produce an IF frequency of 2020 Kc. The output of the RF amplifier and the oscillator are applied to the grid (pin 1) of V103. The difference of these two frequencies, the 2020 Kc IF, is selected by the plate circuit, C131 and L113, which is resonated to 2020 Kc. Plate voltage is applied to V103. through isolation resistor R110 which is bypassed by C130. V103 cathode bias is obtained by means of cathode resistor R108, which is bypassed by C128. No additional bias in the form of AGC voltage or RF GAIN control voltage is applied to the grid of V103.

(5) 2020 KC IF CIRCUITS.—This IF is shown in figure 2-8, and as can be seen, does not utilize any tube

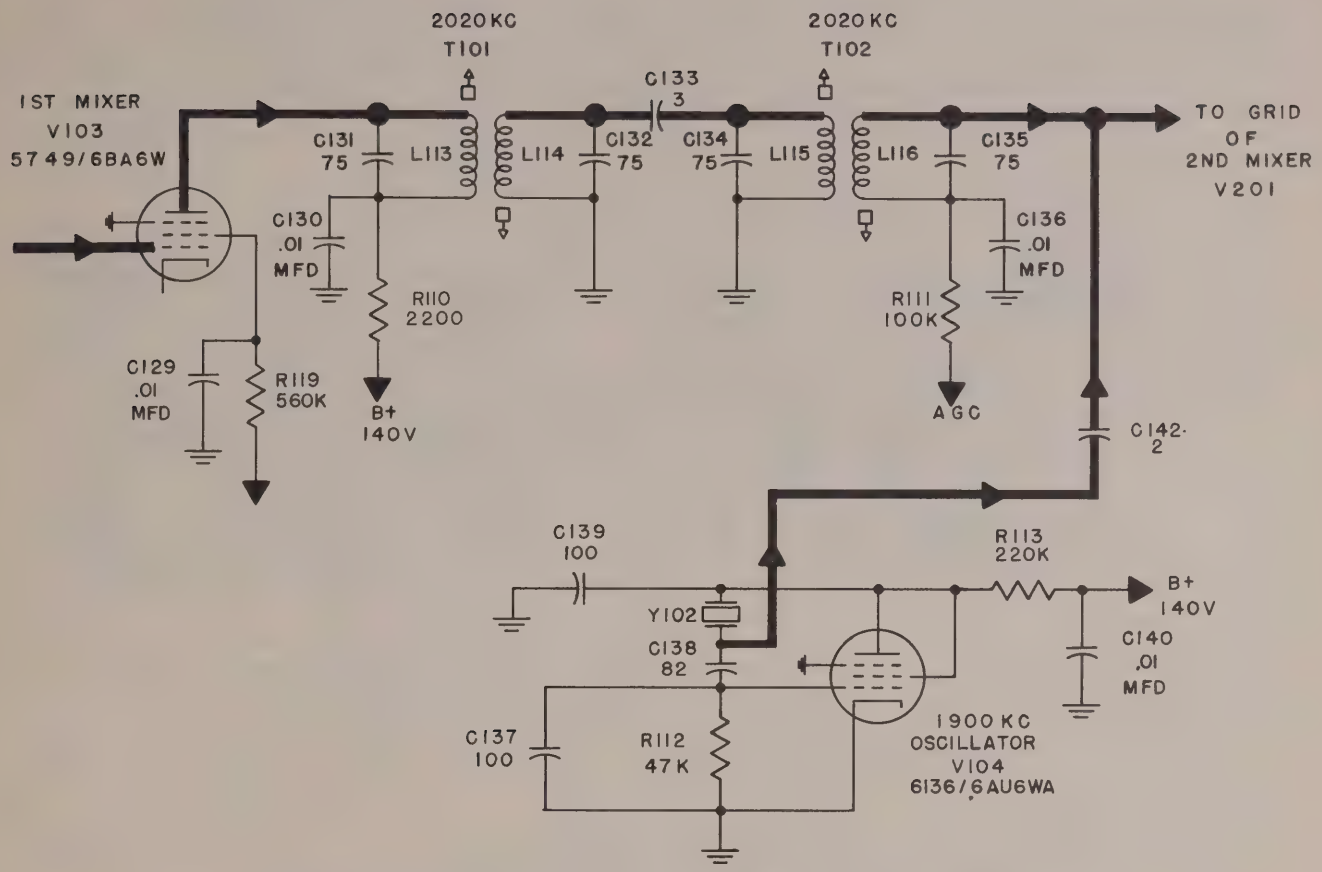


Figure 2-8. Simplified Schematic—2020 Kc and 1900 Kc Oscillator

for amplification. Two coupled transformers, T101 and T102, provide sufficient selectivity to effectively reject undesired image and spurious responses and have bandwidth, when properly tuned, which is in excess of the broadest band width obtained by the 120 Kc IF amplifier. Each transformer has two adjustable iron core slugs. The primaries of T101 and T102 are tuned from the top of the can, while the secondaries are tuned from the bottom. These slugs should be adjusted by the use of the special IF tuning tool provided, which is located on the inside of the front end plate of the Audio/Power chassis. The signal on the secondary of T102 is applied to the grid of the second mixer, V201 through RF inter-chassis connectors E105 and E209. AGC voltage or RF GAIN control voltage is applied to the V201 grid from the AGC bus through decoupling resistor R111 and capacitor C136.

(6) 1900 KC OSCILLATOR.—This oscillator shown in figure 2-8 is designed to operate only with a 1900 Kc crystal. This crystal is a non-temperature controlled type CR-18/U and is supplied with the receiver. It does not change when the receiver is tuned to a new channel frequency. The oscillator uses a pentode type 6136/6AU6WA tube, triode connected, in a Pierce oscillator circuit. The circuit operates in the same fashion as the channel determining oscillator described in paragraph 2a. (3) of this section. The 1900 Kc frequency which appears in the crystal circuit is injected through coupling capacitor C142 and RF inter-chassis connectors E105 and E209 into the grid circuit of the second mixer V201. The second mixer tube is located on the IF chassis and therefore both the 1900 Kc oscillator frequency and incoming 2020 Kc frequency must pass through interchassis connectors E105 (RF chassis) and E209 (IF chassis).

b. IF CHASSIS ASSEMBLY.

(1) SECOND MIXER/120 Kc IF AMPLIFIER.—As shown in figure 2-11 a type 5749/6BA6W tube is used as the second mixer (V201). The 2020 Kc first IF and the 1900 Kc second oscillator frequencies are present in the grid circuit and combine in this tube to produce the 120 Kc IF frequency which is selected by the plate circuit. A test point is provided on the top of the chassis (see figures 2-9) to permit injection of a 120 Kc signal on the control grid of this tube for the alignment of the 120 Kc IF stages. Proper operating

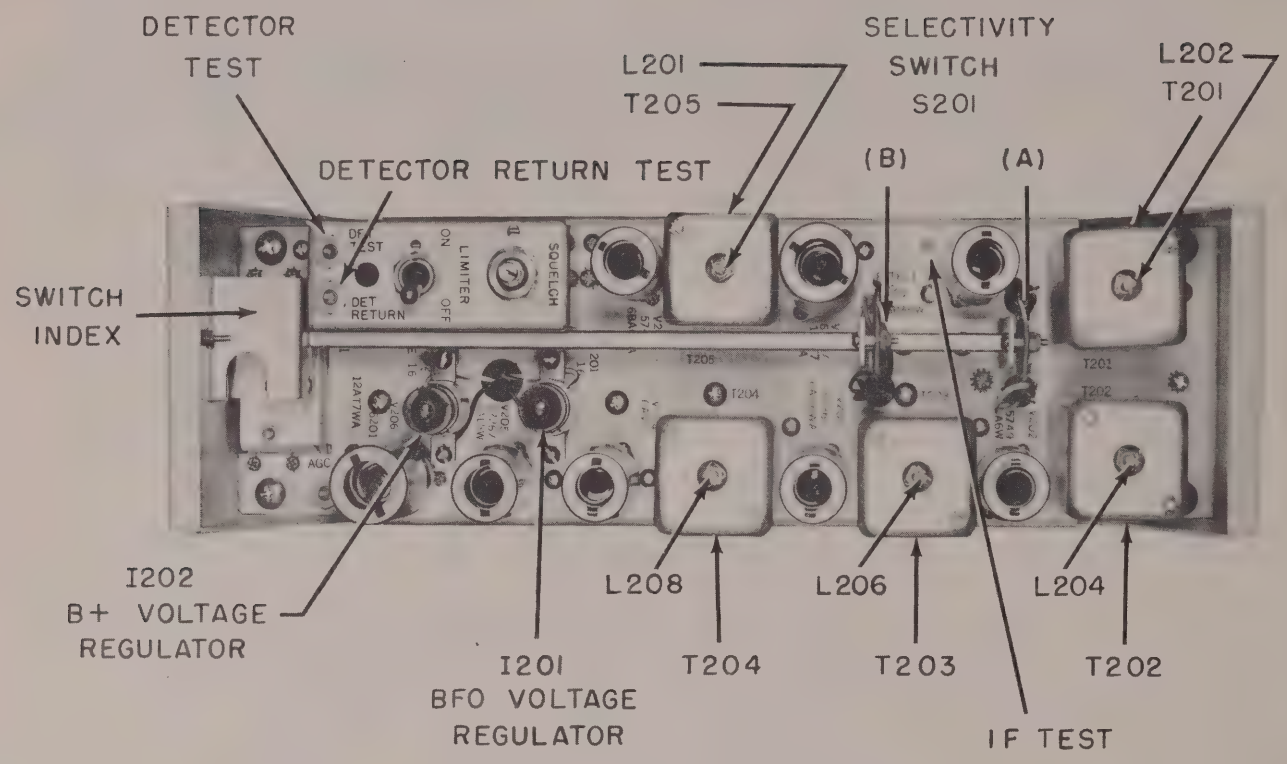


Figure 2-9. Top View of the IF Chassis

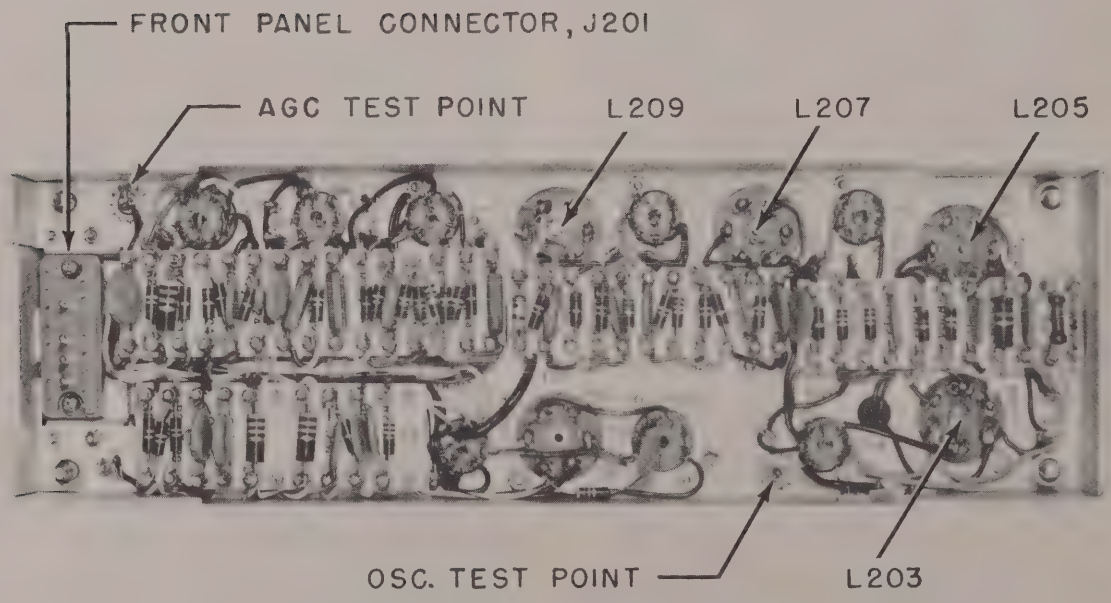


Figure 2-10. Bottom View of the IF Chassis

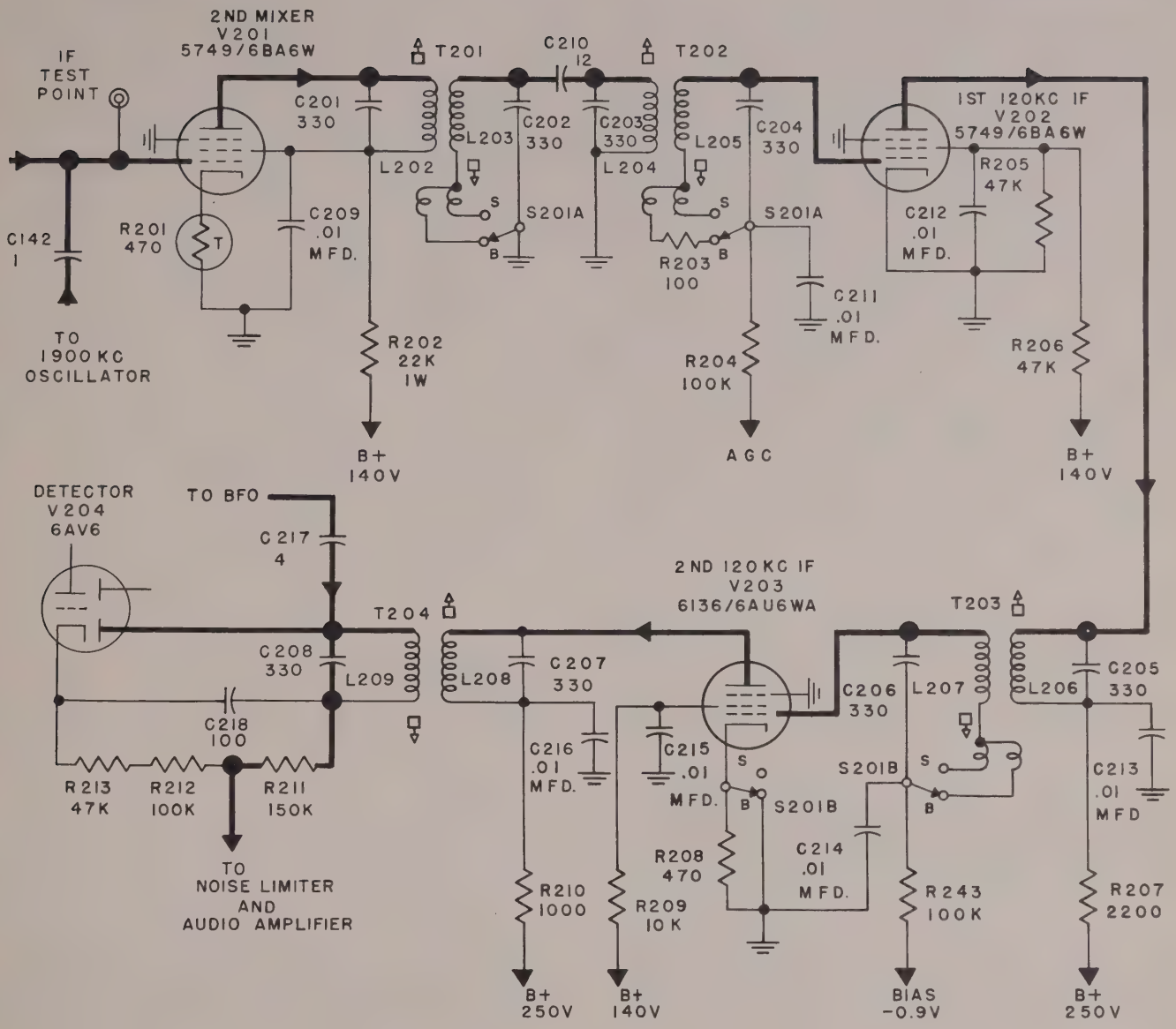


Figure 2-11. Simplified Schematic—2nd Mixer and 120 Kc IF Amplifier

bias is provided by means of cathode resistor R201, which is unbypassed and provides a degree of degeneration which acts to stabilize the receiver gain. AGC voltage or RF GAIN control voltage is applied to the V201 grid. The plate circuit of V201 consists of capacitor C201 and inductance L202 which are resonated to 120 Kc by means of the top powdered iron slug. L202 is coupled to L203 by mutual inductance. Plate and screen voltages are applied to V201 through isolation resistor R202, which is bypassed by capacitor C209. The secondary of T201, T202 and T203 consists of one main winding in series with either of two smaller windings, one of which is used for broad selectivity and the other for sharp selectivity. The broad selectivity winding, being closest to the primary, provides the greatest degree of coupling, while the smaller winding provides much less coupling and is utilized mainly to keep the total secondary inductance the same with either broad or sharp selectivity operation. The selectivity is switched from BROAD to SHARP by means of the front panel SELECTIVITY switch S201. The secondary circuit of T201 consists of L203 and capacitor C202 and is resonated to the proper frequency by means of the bottom slug. The signal is then coupled from T201 to T202 through top coupling capacitor C210. The primary circuit of T202, consists of C203 and L204 and is resonated by the top iron slug. L204 is coupled to L205 by means of mutual inductance coupling. The secondary

winding of T202 also has two coupling windings for broad and sharp selectivity positions. It will be noted that the broad selectivity, or high coupling winding has a series resistor R203, which lowers the "Q" of this coil in the broad selectivity position, thus producing the desired amount of band width. The secondary circuit of T202, which consists of L205 and capacitor C204, is resonated by the bottom powdered iron slug. The signal is then applied to the grid of V202, the first 120 Kc IF amplifier, a type 5749/6BA6W tube. AGC or RF GAIN control voltages are applied through isolation resistor R204 to the V202 grid. C211 effectively bypasses the lower end of the secondary tuned circuit of T202. No cathode bias is provided for this low frequency IF amplifier stage. Proper operating grid bias voltage is present on the AGC control bus and is applied to V202 at all times. The 120 Kc IF signal is amplified in V202 and is present on the plate circuit which consists of C205 and L206 which is resonated to 120 Kc by the top powdered iron slug. B+ voltage is applied to the V202 plate through isolation resistor R207, which is effectively bypassed by C213. Screen voltage is applied to V202 from the junction of voltage dividing resistors R206 and R205. This voltage divider tends to maintain the screen voltage at a relatively fixed value when different amounts of AGC bias are applied to the tube and causes the tube to have greater amount of AGC control. The screen is bypassed by C212. The primary of T203, L206 is coupled to L207 by means of mutual inductive coupling. The secondary of T203 consists of C206 and L207, which has two coupling windings. This circuit is resonated by an adjustable powdered iron slug which is tuned from the bottom of T203. The signal is then applied to V203, a type 6136/6AU6WA tube. Operating bias is applied to the V203 grid through isolation resistor R243 which is bypassed by C214. This bias is approximately —0.9 volts and is the only bias applied to this tube when the SELECTIVITY switch is in the BROAD position. When the SELECTIVITY switch is switched to the SHARP position, resistor R208 is inserted in the cathode circuit, in order to reduce the IF gain and compensate for gain changes between the broad and sharp selectivity positions. This is necessary in order to have approximately the same squelch opening level, AGC action and RF gain control characteristics for both the broad and sharp selectivity positions. V203 operates as a high level IF amplifier and utilizes a sharp cutoff pentode, type 6136/6AU6WA, in order to provide the greatest degree linearity; therefore, no AGC bias is applied to the grid of V203. Resistor R209 drops the voltage from the 140 volt B+ source to the screen of V203. The screen is bypassed by capacitor C215. Both V202 and V203 are very high gain amplifier stages

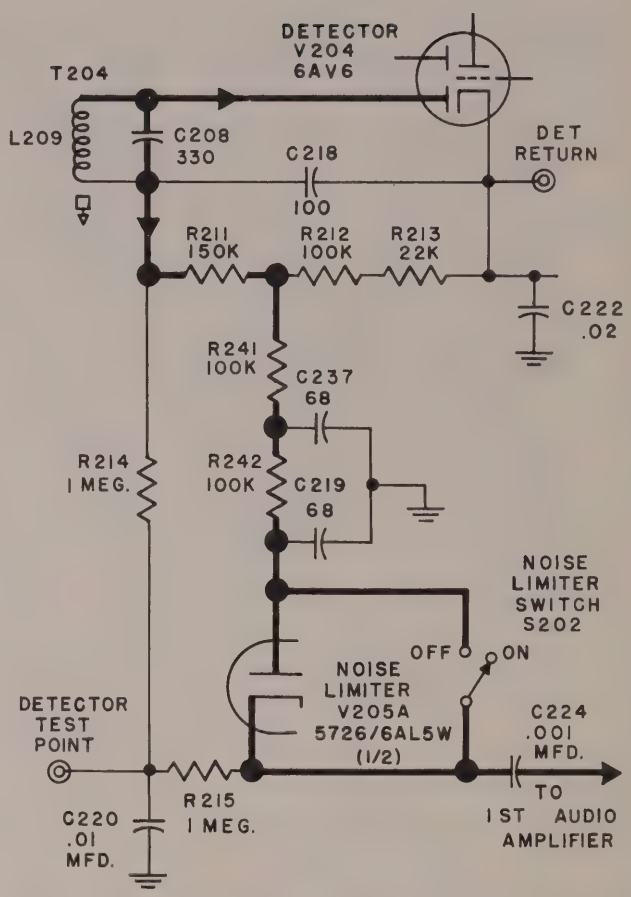


Figure 2-12. Simplified Schematic—Detector-Noise Limiter

and provide IF gain in excess of 200 per stage. The plate circuit of V203 is the primary of T204, L208 and C207, which are resonated to 120 Kc by the top powdered iron slug. L209 and C208 form the secondary circuit of T204 and are resonated to 120 Kc by tuning the bottom powdered iron slug. The primary and secondary windings of T204 are highly coupled in order to compensate for the loading effects of the diode plate of V204, a duo-diode-triode type 6AV6 tube.

(2) DETECTOR-NOISE LIMITER.—As indicated in the simplified schematic figure 2-12, one diode section of the type 6AV6 tube (V204) is used as a detector. The detected audio voltage appears across C218 and load resistors R211, R212 and R213, which are connected between the return of the secondary of T204 and the cathode of V204. C218 bypasses most of the IF component. A portion of the audio signal developed across the load resistors passes through a double section IF filter which consists of R241, C237, R242 and C219. The audio is then applied to the noise limiter tube which consists of one half of a type 5726/6AL5W tube (V205A). When the NOISE LIMITER switch (S202)

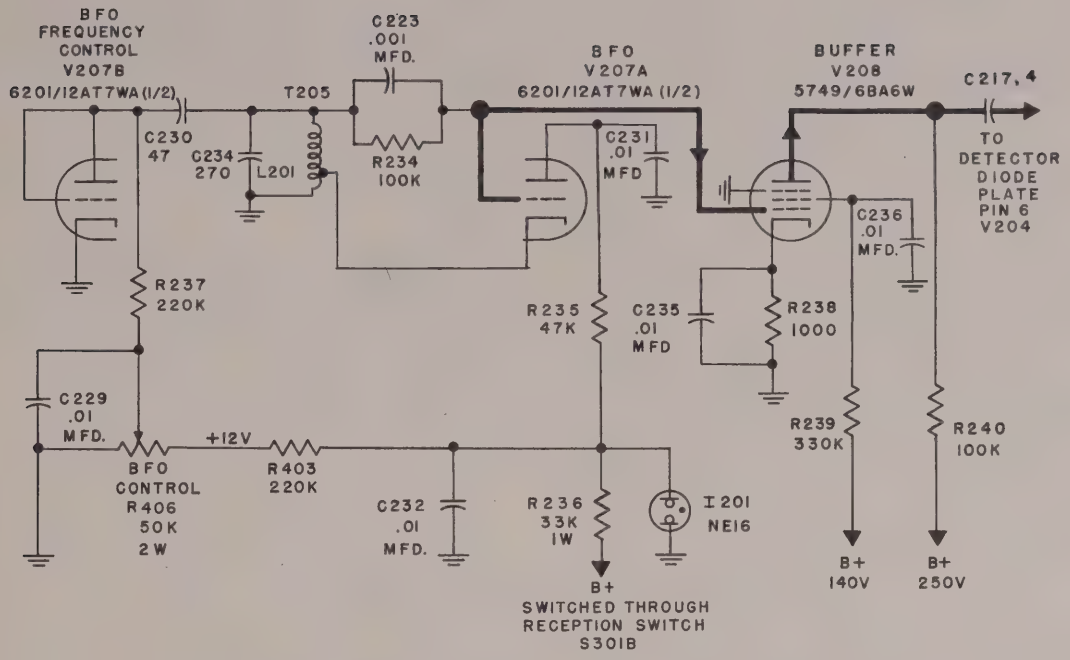


Figure 2-13. Simplified Schematic—BFO Oscillator-Control-Buffer

is in the OFF position (switch showing continuity) the audio bypasses the noise limiter tube and is coupled through C224 to the grid of the first audio amplifier V206.

The noise limiter functions in the following manner: when the NOISE LIMITER switch (S202) is in the ON position, a series self-adjusting noise limiter or clipper circuit is placed between the detector and the first audio. A negative voltage, proportional to the carrier level, is developed across the detector load which is composed of R211, R212 and R213. This voltage is filtered through a network composed of R214 and C220. This network has a time constant sufficiently long to prevent any sharp noise impulses from affecting this voltage which is applied through the cathode load resistor R215 to the cathode of noise limiter tube, V205A, one half of a 5726/6AL5W dual diode. The rectified or detected signal is divided by means of R211, R212 and R213 and a portion of it is applied to the plate of the noise limiter through the RF filter R241 and R242. The average voltage applied to the plate is less negative than that applied to the cathode. This, in effect, makes the plate positive with respect to the cathode. The diode will then conduct and the audio signal will be passed on through the diode and coupling capacitor C224 to the grid of the first audio amplifier. When noise peaks or modulation peaks exceed approximately 60% modulation, the plate will become negative with respect to the cathode, whose voltage is kept unchanged by the long R214, C220 time constant, thus stopping diode conduction to that portion of the signal exceeding 60% modulation. Therefore, any undesired noise which exceeds 60% modulation will be completely blocked. This type of noise limiter is most effective on sharp impulse noise, which is high in amplitude, of short duration and having a slow repetition rate. Switching the noise limiter ON or OFF will change the audio level by approximately one db. The noise limiter may be switched in or out of operation for all modes of reception. It is most useful for A2-A3 reception.

(3) BFO OSCILLATOR-BFO CONTROL-BUFFER.—Figure 2-13. These circuits function only during A1 or A1 BROAD operation and consist basically of a variable beat frequency oscillator with a center frequency of 120 Kc; a BFO frequency control tube which permits varying this BFO frequency from the front panel or a remote position; and a buffer amplifier stage which is used to isolate the BFO oscillator from signal level changes present at the detector diode plate. The oscillator frequency is normally adjusted to exactly 120

Kc with the BFO control at its midpoint and, in conjunction with the BFO control tube and BFO control, the frequency can be varied over a range of approximately ±2000 cycles. The BFO oscillator is stable within 100 cycles for changes of ±10% in line voltage, temperature changes from —15°C (+5°F) to +50°C (+122°F) and for RF gain variations of 100 db. The BFO oscillator consists of one half of a 6201/12AT7WA dual triode (V207A). This triode oscillator is tuned to the correct frequency by means of C234 and L201 whose inductance is adjusted by a powdered iron slug in the top of T205. L201 has a tap which is connected to the cathode of V207. This tap provides the proper amount of feedback for stable oscillation. Grid conduction during oscillation causes a negative voltage to appear across the grid resistor R234. A positive voltage, which is switched through the RECEPTION switch (S301B) in A1 or A1 BROAD operation, is applied through R236 to a NE16 neon negative glow lamp (I201), which regulates the BFO plate supply voltage. This regulated voltage is then applied through plate isolation resistor R235 to the plate of the BFO oscillator. The plate is effectively at ground potential due to the bypassing action of C231. The BFO frequency control tube consists of one half of a type 6201/12AT7WA tube (V207B). This triode tube is diode connected and functions as a reactance tube. Capacitor C230 is in series with the BFO frequency control tube. This effectively puts C230, in series with the reactance tube, across the BFO tuned circuit. Depending on the amount of conduction in the BFO frequency control tube, different effective amounts of C230 capacity are applied across T205. This varies the resonance frequency of T205. The effective plate resistance of the BFO frequency control tube is varied by applying an adjustable amount of positive voltage through plate load resistor R237. This adjustable amount of B+ voltage is obtained from regulator tube I201 and reduced through dropping resistor R403 and applied to the BFO control R406 which is mounted on the front panel of the receiver. This control can apply from 0 to +12 volts to resistor R237. The amount of voltage which appears across the BFO frequency control tube plate and cathode is a very small portion of this voltage. For remote control of the BFO, a remote adjustable regulated voltage is substituted in place of R406. The BFO output is coupled to the grid of the buffer amplifier V208, which is a type 5749/6BA6W tube. Buffer operating bias is obtained from cathode bias resistor R238 which is bypassed by C235. This tube operates as a linear amplifier (class A), and the cathode bias provided is in excess of any grid voltage drive. Screen grid voltage is applied through R239. The screen is bypassed by capacitor C236. The amplified BFO frequency appears across load resistor R240. The amplified BFO is then coupled to the detector diode plate of V204 by coupling capacitor C217. The buffer stage is utilized to provide sufficient BFO injection voltage and to prevent strong incoming signals that may be present at the detector diode plate from coupling over to the BFO and affecting its frequency stability.

(4) AUTOMATIC GAIN CONTROL (AGC).— An amplified and delayed type of automatic gain control is utilized, as indicated in the simplified schematic, figure 2-14; delayed meaning a voltage delay, not a time delay. This circuit functions in such a way that AGC action is delayed until the incoming carrier strength reaches a pre-determined level and then a control voltage is applied to the stages to be regulated. In this circuit, the rectified IF voltage output of the detector is divided across load resistors R211, R212 and R213. A small portion of this voltage is applied through R216, which with C221 acts as a filter, to the grid of the triode portion of V204, a type 6AV6 tube. B+ voltage is applied to the triode plate of V204 and negative voltage from a —60 volt source is applied through R218 and R217 to the cathode. The tube may be considered as a variable resistor in a voltage divider with the cathode at a tap. The resistance values are proportioned so that in the absence of signal, the voltage drop through the triode portion of V204 from the B+ voltage is less than the B— drop through R218 and R217. Therefore, the cathode is at a slightly positive potential at this time. The pin 5 diode plate of V204 is connected to ground through R231 and R232. Therefore, the cathode of V204 is positive in respect to this diode plate and no conduction is possible between these tube elements. When a signal is received, the rectified RF voltage appearing across load resistor R213 is applied through R216 to the grid of V204. This voltage is negative in respect to the cathode and therefore begins to reduce the plate current going through V204. This increases the plate resistance of V204 and the potential of the cathode will decrease. As the signal increases, the triode section will be biased greater and a point will be reached when the cathode of V204 will no longer be positive with respect to ground and will actually become negative. When this point is reached, the cathode is now negative in respect to pin 5 diode of V204 and conduction between the two takes place. A portion of the negative voltage on the cathode of V204 is developed across load resistors R231 and R232. This negative voltage is connected to the AGC line through RECEPTION switch (S301B) and applied to the RF amplifier (V101), the first mixer

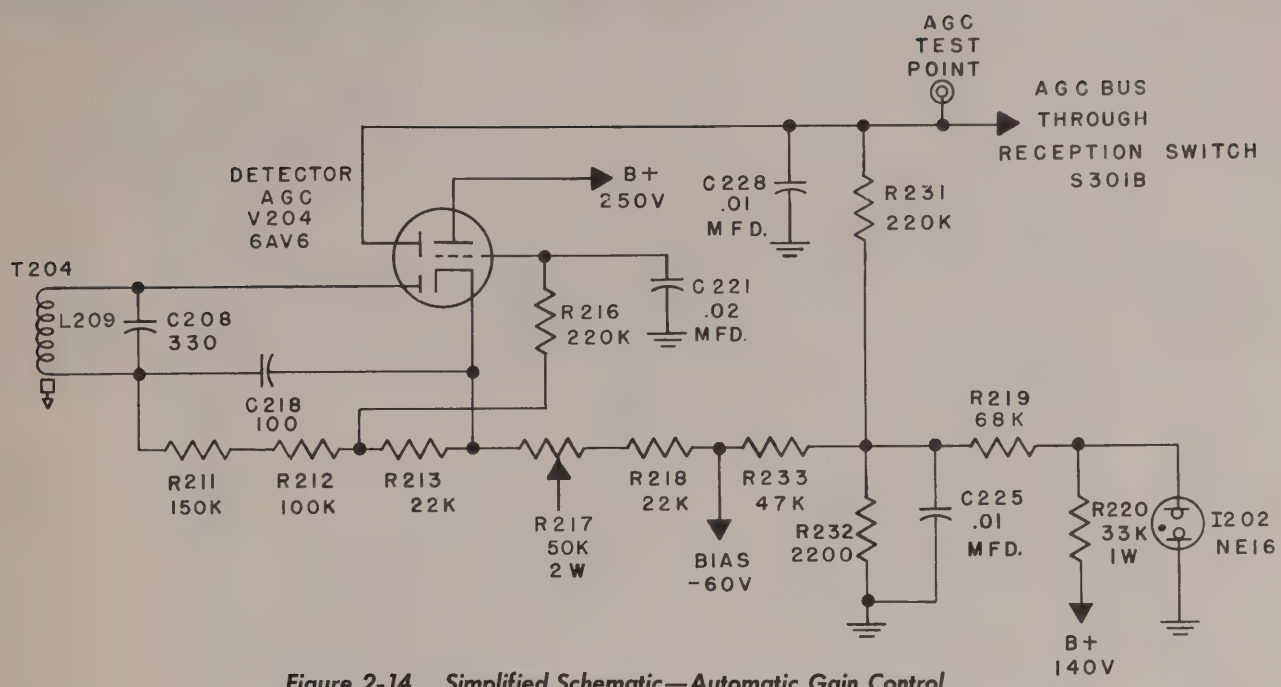


Figure 2-14. Simplified Schematic—Automatic Gain Control

(V103), the second mixer (V201), and the first 120 Kc IF amplifier (V202). The AGC voltage, as it increases, reduces the effective gain of the various tubes controlled. This voltage may be checked at the AGC TEST point, on the IF chassis. By proper selection and proportionment of R213, R217 and R218, it is possible to delay the conduction from the cathode of V204 to diode plate pin 5 until the incoming signal has reached a pre-determined level. This gives the AGC a delayed action.

A negative voltage of approximately —0.9 volts is supplied from a bias source through R231 to the AGC line. This bias voltage applied to the AGC bus is varied automatically to compensate for overall receiver gain changes due to variation of the line voltage. B+ voltage, regulated by R220 and negative glow lamp I202, is coupled through dropping resistor R219 to resistor R232. The —60 volt bias supply is likewise coupled to the common resistor R232. The positive voltage bucks out a portion of the negative voltage fed through R233 and gives an average voltage of —0.9 volts across R232. If the AC line voltage increases, the B voltages applied to the various tubes of the receiver will increase, thus increasing the gain of the receiver, but the B voltage supplied through R219, having been regulated, remains constant and bucks out a portion of the bias supplied to R233. Since the —60 volt bias supply voltage has increased to over —60 volts with the line voltage rise, the negative voltage developed across R232 will increase by a larger percentage than the AC line voltage has increased. This additional bias voltage is applied to the AGC bus through R231 and effectively decreases the gain of all stages connected to the AGC bus. Values of R219, R232 and R233 have been chosen to properly compensate for such line voltage variation. The AGC system will hold the audio output constant well within three db over the range of ten times the AGC threshold (beginning of operation approximately five microvolts) and 10,000 times AGC threshold.

(5) SQUELCH OR SILENCER CIRCUIT.—A squelch system consists essentially of a method of assessing the reception conditions and disabling the receiver when the desired signal is not present. In the simplified squelch circuit in figure 2-15 silencing of the receiver is accomplished by biasing the grid of the first audio amplifier, V206A, beyond cutoff. The squelch circuit is only operative in the A2-A3 reception position. One triode section, V206B, of a 6201/12AT7WA type tube is used as the squelch tube. The plate load resistor R226 of this tube is connected to the junction of the R224-R225 B+ voltage divider. With one end of R226 connected to the cathode of the first audio tube V206A and the other end to the grid resistor R221 of V206A, any current flow through R226 causes a voltage drop which makes the grid more negative with respect to its cathode and will bias the first audio to cutoff. When the squelch tube does not conduct, there is no voltage drop across R226 and the audio amplifier functions normally.

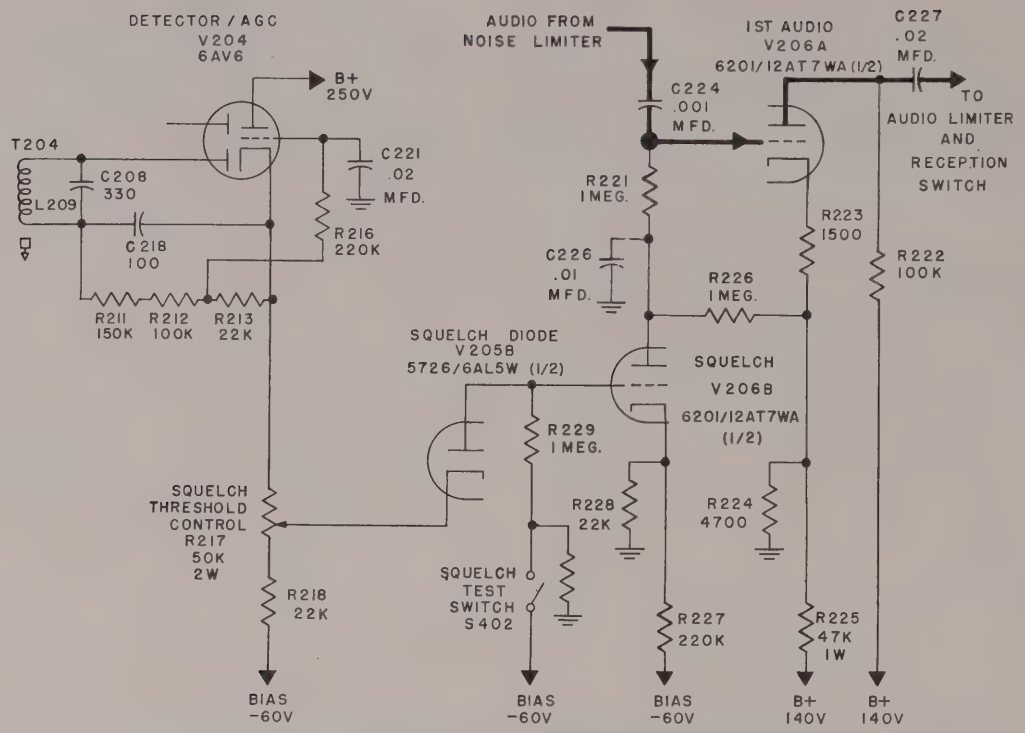


Figure 2-15. Simplified Schematic—Squelch and First Audio

The squelch circuit operates in the following manner: In the absence of signal, no negative rectified signal is applied to the V204 grid. Therefore, the cathode of V204 is positive with respect to ground (as explained under automatic gain control (4)). SQUELCH Threshold control R217 has a resistance value which permits the cathode voltage of the Squelch Diode, V205B, to be adjusted from the positive potential on the V204 cathode end of the control to the negative voltage on the R218 end. Since the plate of the squelch diode is returned to ground through load resistors R229 and R230, no conduction is possible through the squelch diode, since it will not conduct with positive potential on the cathode with respect to the plate. As the SQUELCH control arm is rotated towards R218, the cathode of V205B squelch diode will go negative and conduction will take place, through the squelch diode, thus applying a negative voltage to the grid of the squelch tube V206B. A fixed negative potential is continuously applied to the V206B cathode through R227 and R228 to force conduction. The squelch tube drawing current through R226 causes sufficient negative voltage to be developed on the grid of the first audio amplifier (V206A) to cut it off. When a signal is received, the negative voltage on the grid of the squelch tube V206B becomes greater than the fixed negative cathode bias and begins to bias the squelch tube V206B to cutoff. When the incoming signal has increased to a point where the squelch tube V206B is completely cutoff (non-conducting) no voltage drop will be developed across R226 and the first audio tube can amplify the audio voltage received from the noise limiter through coupling capacitor C224. The amplified audio is developed across plate load resistor R222. Coupling capacitor C227 couples the audio to the audio limiter and RECEPTION switch, which is located on the Audio/Power Supply chassis. Under normal operating conditions, in the absence of a signal, if the SQUELCH threshold control R217 is advanced from a counterclockwise position towards a clockwise position, a point is reached where the squelch will change from an unsquelched condition to a squelched condition. If the squelch control is advanced slightly further in a clockwise position and left in this condition, the squelch circuit is adjusted for its most sensitive condition. Signals of at least six db below the actual sensitivity of the receiver, during A2-A3 reception, will fully operate the squelch circuit. If the SQUELCH threshold control R217 is advanced fully clockwise, the squelch will require an input signal of at least 100 μv input before the squelch circuit will operate. With SQUELCH threshold control R217 in a position which squelches the first audio, the squelch can be disabled by applying a high negative voltage through the SQUELCH test switch (S402) and resistor R229 to pin 7 of the V206B squelch tube grid. By applying a high negative voltage

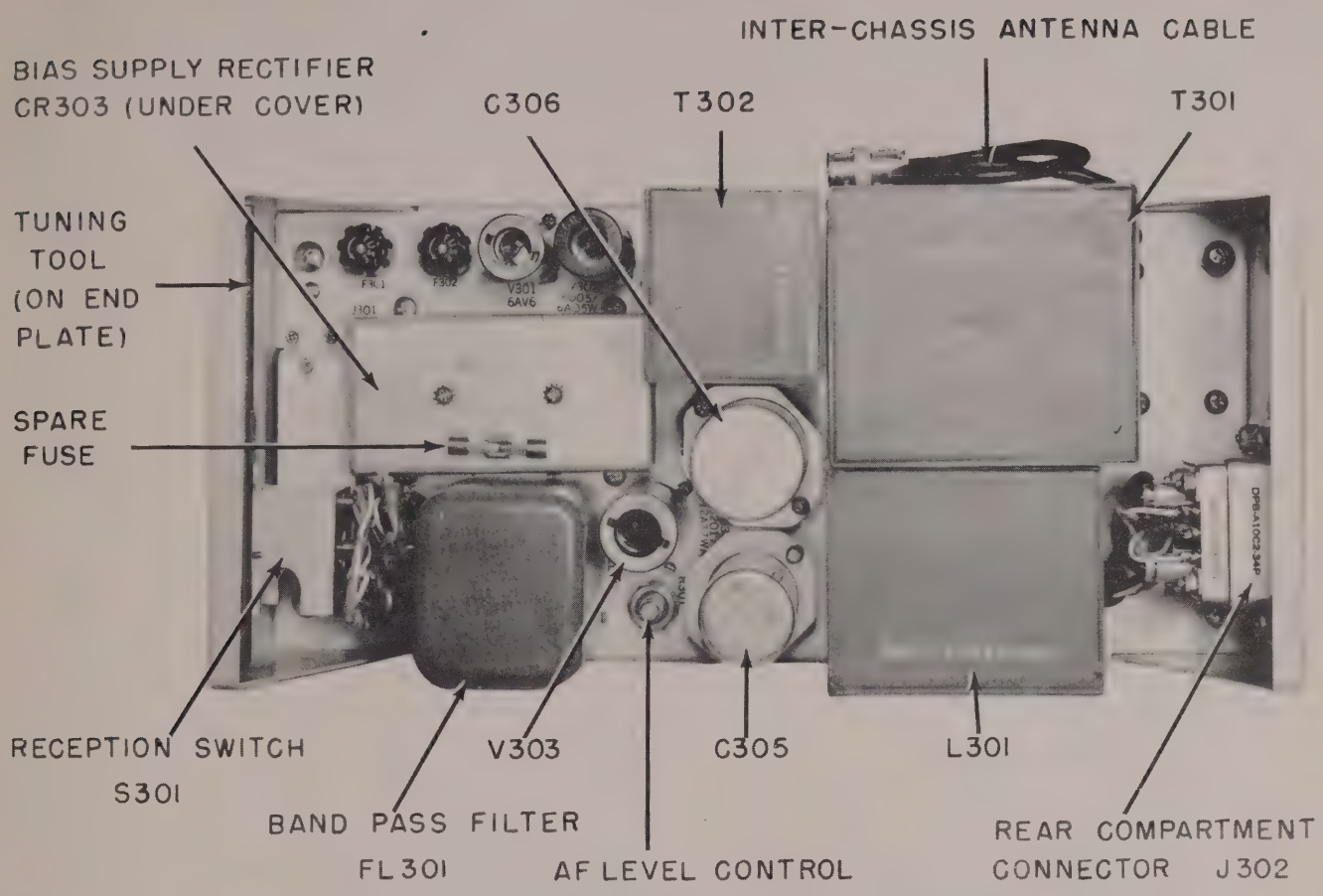


Figure 2-16. Top View of the Audio/Power Supply Chassis

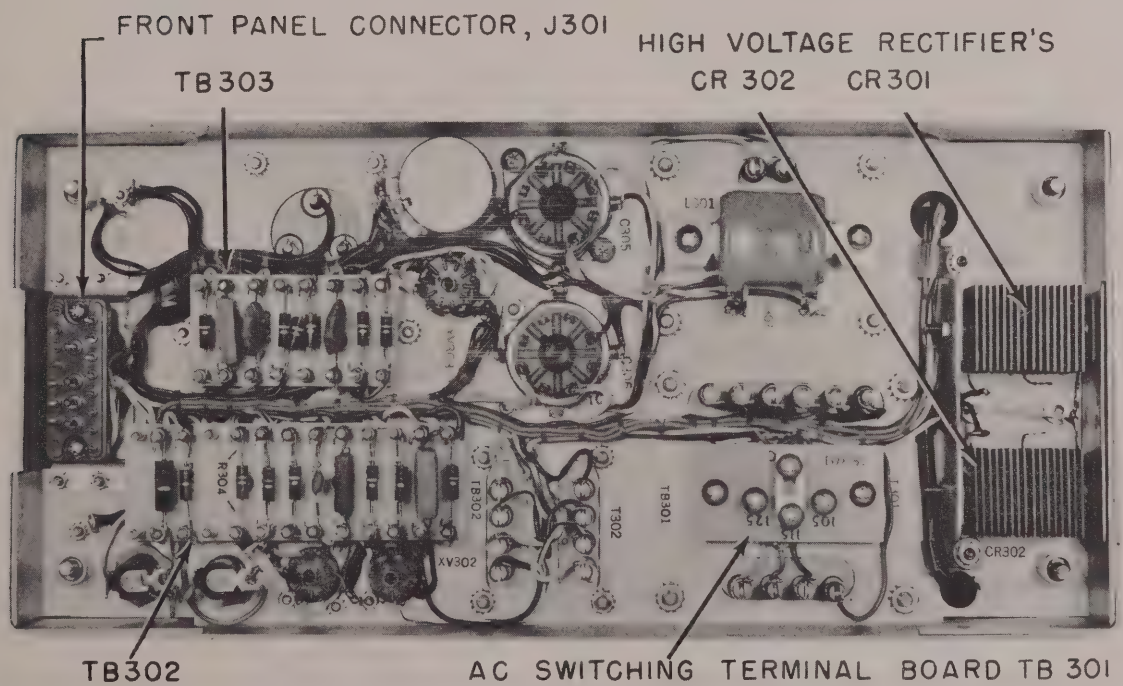


Figure 2-17. Bottom View of the Audio/Power Supply Chassis

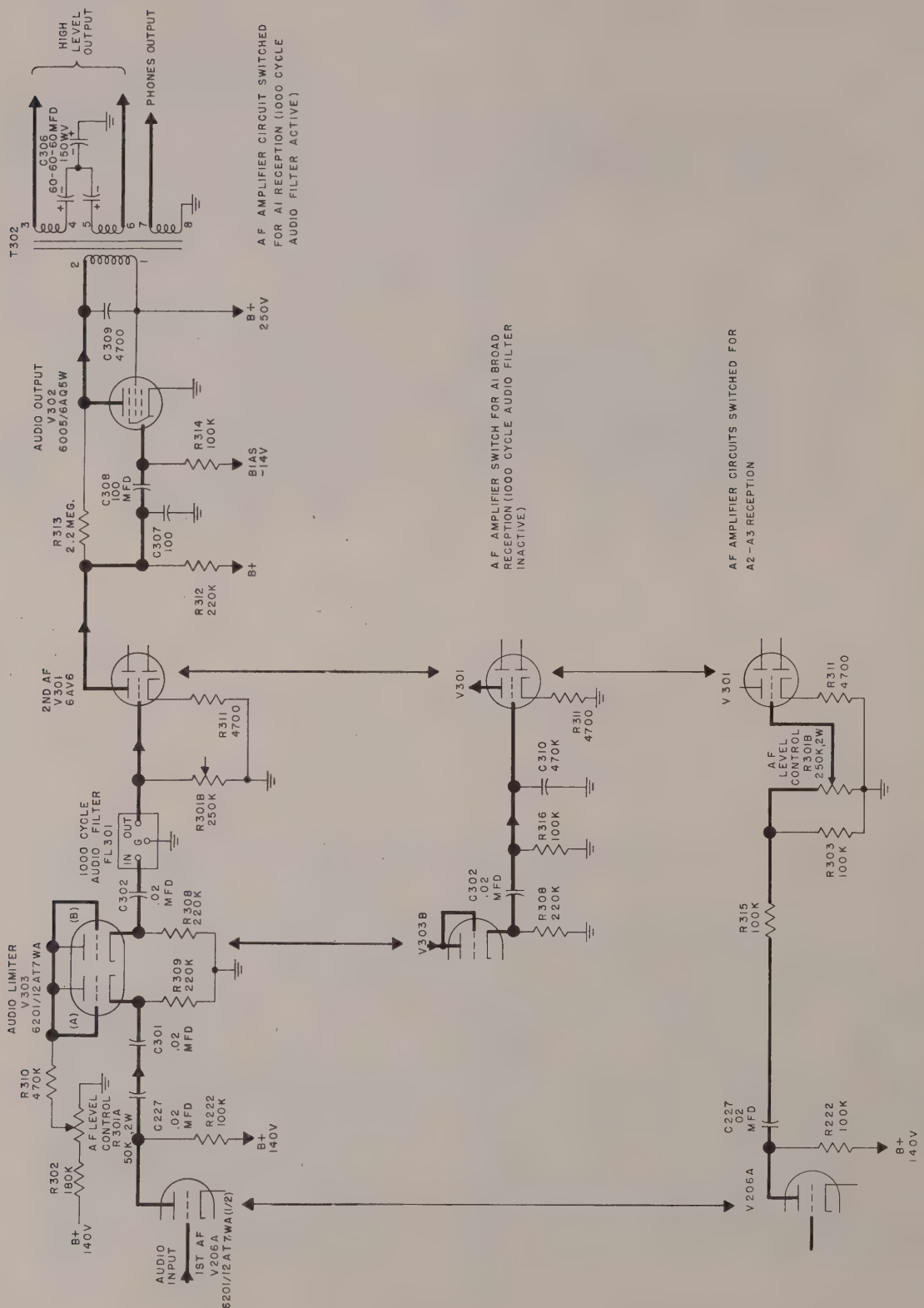


Figure 2-18. Simplified Schematic—Audio Amplifier

through the LOCAL-REMOTE switch, and RECEPTION switch through R229, the squelch circuit can be disabled remotely. Proper operating grid bias is applied to the first audio stage V206A by cathode resistor R223. The squelch circuit operates in such a manner that increases or decreases in the amount of modulation percentage will in no way increase or decrease the amount of squelch opening. Under normal operating conditions, the squelch threshold control should be set at a point where the squelch has just closed. Under this condition the receiver has the greatest sensitivity. Under some circumstances, where relatively strong desired signals are to be received and there are weak interfering signals on the same frequency, it is possible to increase the squelch threshold control clockwise to a point where the weak interfering signal will not open the squelch but strong desired signals will operate it completely.

c. AUDIO-POWER SUPPLY CHASSIS ASSEMBLY.

(1) AUDIO AMPLIFIER FOR A-1 RECEPTION.—The audio amplifier, as indicated in the simplified schematic figure 2-18, consists of the first audio amplifier (V206A), which is located on the IF chassis-assembly, an audio limiter tube (V303), a 1000 cycle audio filter, the second AF amplifier (V301), the audio output tube (V302) and the audio output transformer (T302). Inverse feedback is used to minimize the effects of audio output load changes on the audio output level. Due to the inverse feedback, the audio output is maintained within two db over a load variation of from 200 to 600 ohms. Overall distortion is less than seven percent for 1.5 watts with a load of 200 to 600 ohms, at the high output level AUDIO (J505) or REMOTE (J503) connectors located on the rear filter assembly of the case. At least 15 milliwatts output is available for a 600 ohm load at the head-telephone jack located on the front panel of the receiver. The audio frequency response is flat within two db over the range of 300 to 3500 cycles. Above 3500 cycles, the response decreases, and at 30,000 cycles is down more than 45 db. The lower audio frequency response drops off rapidly below 200 cycles and is down at least 20 db at 60 cycles.

(*a*) AUDIO LIMITER.—The audio output from V206A plate circuit is coupled through coupling capacitors C227 and C301 to the cathode resistor R309 of the 6201/12AT7WA audio limiter tube (V303A). The audio is coupled through V303 to its other cathode resistor R308. An adjustable B+ voltage is applied from R301A, the audio limiter control, through R310 to the combined plates of V303. Both sections normally conduct equally without any signal input. When the positive peaks of an audio signal applied to the input cathode pin 8 of the audio limiter tube reach a potential about equal to the plate voltage, the input section (V303A) will cut off thereby clipping the positive peaks. However plate current will continue to conduct through the second section (V303B) and the cathode resistor R308. When negative audio peaks applied to the V303A cathode reach a certain point, the first section (V303A) is conducting as much current as it possibly can through R310. Any further increase in the audio peak will not produce more current flow. Under these conditions, the plate voltage is nearly zero or negative and current through the second section is at its lowest possible value, or cutoff, thus producing clipping of the negative peaks. The level at which the audio limiter will operate is controlled by the audio limiter control R301A (AF LEVEL). This control has a range which will permit the limiting of the audio head-telephone level output (maximum) to be adjusted from below 60 microwatts to at least 15 milliwatts during A1 or A1 BROAD reception. When a sine wave audio input is applied to the V303A cathode, resulting wave shape after audio clipping or limiting will then be a square wave as observed at the cathode of V303B. The audio is then coupled through capacitor C302 to the input of the 1000 cycle audio filter FL301. This filter is used to provide the receiver with audio selectivity for A1 reception. When the BFO control is adjusted for a 1000 cycle beat note, when receiving a desired signal, any undesired signal (and desired signals) which produce a beat note other than 1000 cycles will not be received as readily. The 1000 cycle audio filter has a band width at the —6 db point of approximately ±225 cycles. This is wide enough to permit receiving signals under adverse conditions, such as line voltage variations, temperature changes and RF GAIN control setting changes. The signal is coupled to the grid of the second AF amplifier (V301) from the output terminal of the 1000 cycle audio filter. The output impedance of the 1000 cycle filter is 220,000 ohms; therefore, the load resistance presented by R301B is necessary to properly terminate the 1000 cycle audio filter, so that it will produce its rated attenuation characteristics, and provide a DC return path for the grid of V301.

(*b*) AUDIO AMPLIFIERS.—Operating bias is provided V301, audio amplifier, by cathode resistor R311, which is unbypassed, thus providing a degree of degeneration which tends to stabilize the audio gain and reduce its distortion. B+ voltage is supplied to V301 plate through load resistor R312. The amplified audio present at the plate is coupled through capacitor C308 to the grid of the audio output tube V302, which

uses a type 6005/6AQ5W tube. V302 grid bias of —14 volt is obtained from the R304-R305 divider, which is fed by the —60 volt receiver bias supply, and is applied through grid resistor R314 to the grid of V302. B+ voltage is supplied directly from the 250 volt source to the screen of V302 and through the primary winding of T302, the audio output transformer, to the plate circuit. Degeneration is obtained by means of R313 which couples some of the audio present at the plate of V302 back to the plate circuit of V301. By limiting the size of C308 and by the additional use of C307 and C309, the proper audio frequency response shaping is accomplished. The audio output transformer T302 has two output windings, one of which is the high level output and is used for speaker and remote loads. The output can be adjusted by the audio level control for a maximum output of at least one and one-half watts. The AF LEVEL control is in reality a dual control which functions as R301A to control the audio limiting level for A1 reception, and as R301B to control the volume for A2-A3 reception. The load presented to the winding of T302 may be varied from below 200 ohms to at least 600 ohms with less than two db change in output level. The other output winding is a low impedance winding of approximately four ohms, and supplies a maximum output slightly higher than 15 milliwatts to a pair of 600 ohm headphones. The headphones in no way load this winding and thus have no noticeable effect on the high level output winding. All personnel are cautioned not to connect a low impedance

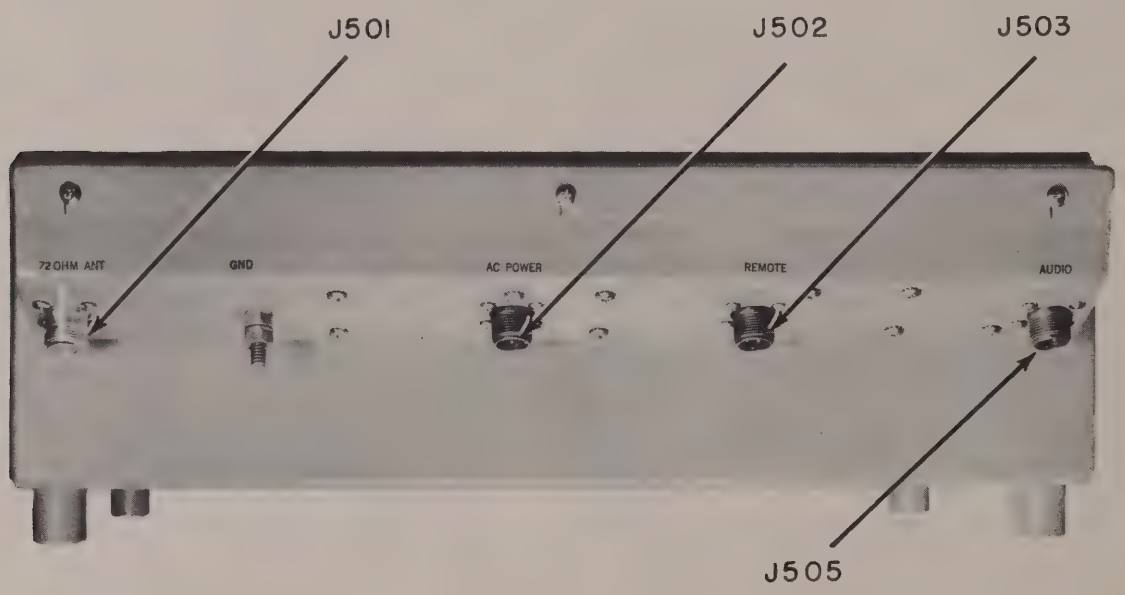


Figure 2-19. Outside View of the Rear Filter Compartment

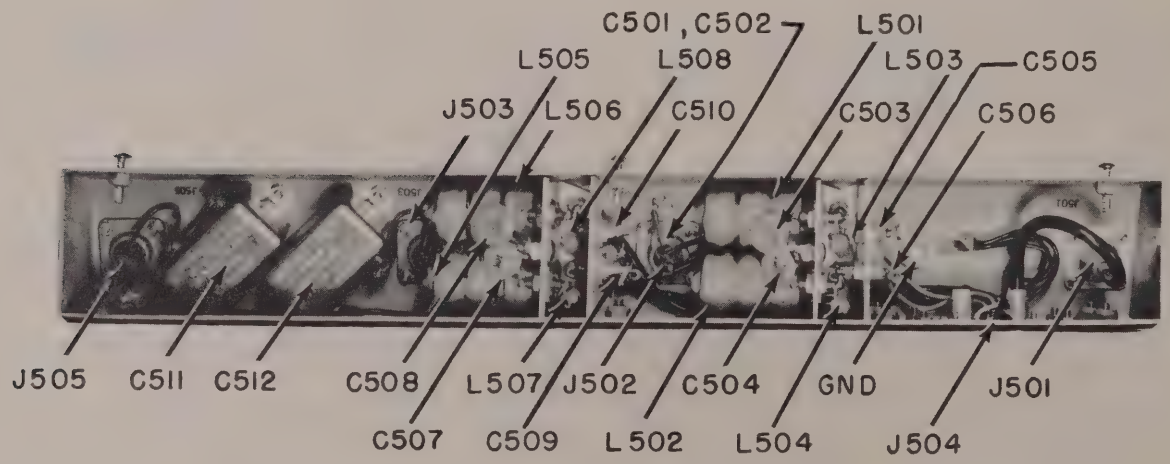


Figure 2-20. Inside View of the Rear Filter Compartment

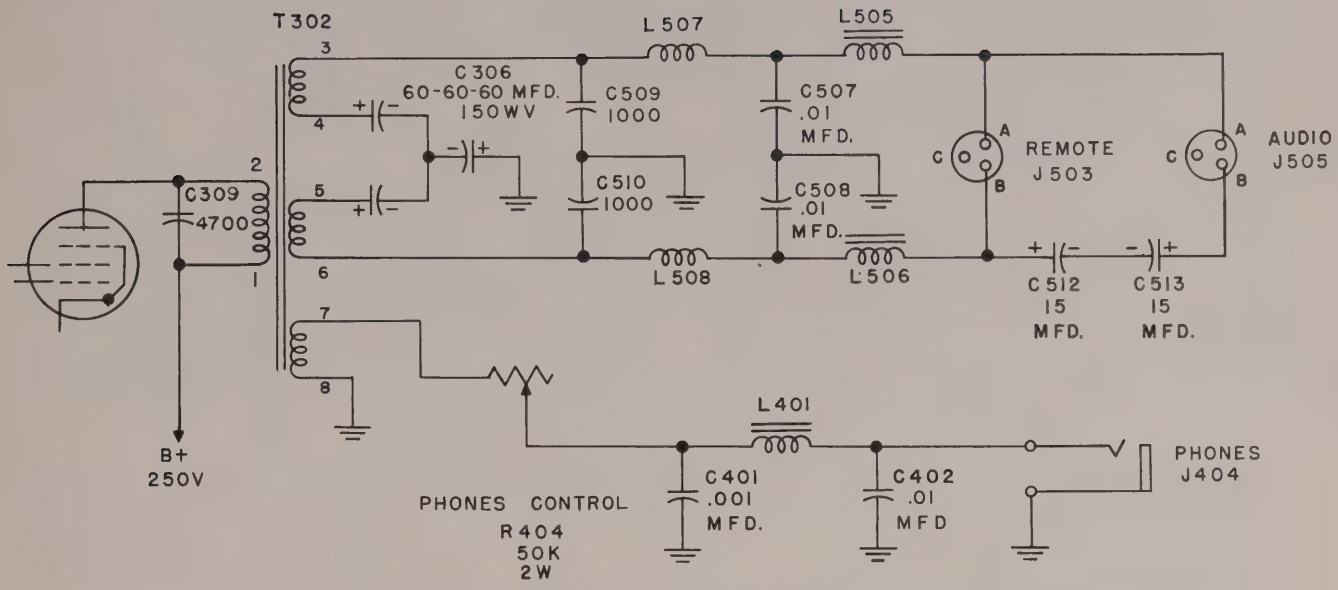


Figure 2-21. Simplified Schematic, Audio RF Filters

speaker or headphone into the head-telephone jack. In order not to materially effect the output load impedance of V302 it is recommended that the headphone input impedance be at least 250 ohms.

(*c*) A1 AND A1 BROAD RECEPTION AUDIO CIRCUIT.—Two positions are used on the reception switch S301 for A1 type of reception. These are indicated as A1 and A1 BROAD reception. Both types of reception are identical, excepting that on A1 BROAD the 1000 cycle audio filter is switched out and is inoperative. Figure 2-18 indicates the only circuit rearrangement that is made in switching from A1 to A1 BROAD reception. The signal is coupled from the audio limiter V303B cathode pin 3 through coupling capacitor C302 to the grid of the second audio amplifier V301. The grid resistor R316 and shunt capacitor C310 compensate for the insertion loss of the audio filter and the audio response change due to switching the 1000 cycle filter out.

(*d*) A2-A3 RECEPTION AUDIO CIRCUIT.—The audio amplifier circuit from the grid of V301 to the output is identical for all modes of reception. For A2-A3 reception both the audio limiter (V303) and the 1000 cycle audio filter are switched out of the circuit as shown in figure 2-18. The audio present on the plate of V206A is coupled through capacitor C227 to the voltage divider R315 and R303, which compensate for the gain change between A1 type of reception and A2-A3 reception. The audio is then applied to the audio level control R301B which is adjustable over a range of at least 50 db in a linear manner. The audio is then coupled directly to the grid of V301.

(*e*) AUDIO RF FILTERS.—The audio RF filters are shown in figure 2-21. The high level output winding of T302, is a split winding with a three section electrolytic capacitor C306 used for DC blocking at the electrical (AC) mid-point of the transformer winding so that remote control functions can be inserted by the two leads indicated. (See J503, Figure 2-21). The high level winding of T302 has an output impedance of approximately 300 to 400 ohms, which is center tapped through capacitor C306 to ground. This winding is electrostatically shielded and balanced making it well suited for connecting remote circuits. A two section filter is employed between this winding and the AUDIO receptacle (J505) and the REMOTE receptacle (J503), which are located on the rear filter compartment. One filter section, composed of L505, L506, C507 and C508 is effective over a range of approximately 200 Kc to 8 Mc. Another section composed of L507, L508, C509 and C510 is effective above 8 Mc. The high level audio output passes through these two filter sections and is available at the REMOTE receptacle J503. In addition, the remote control voltages (DC) are coupled through this remote receptacle. Local speakers, or other loads may be connected to the AUDIO receptacle (J505), which

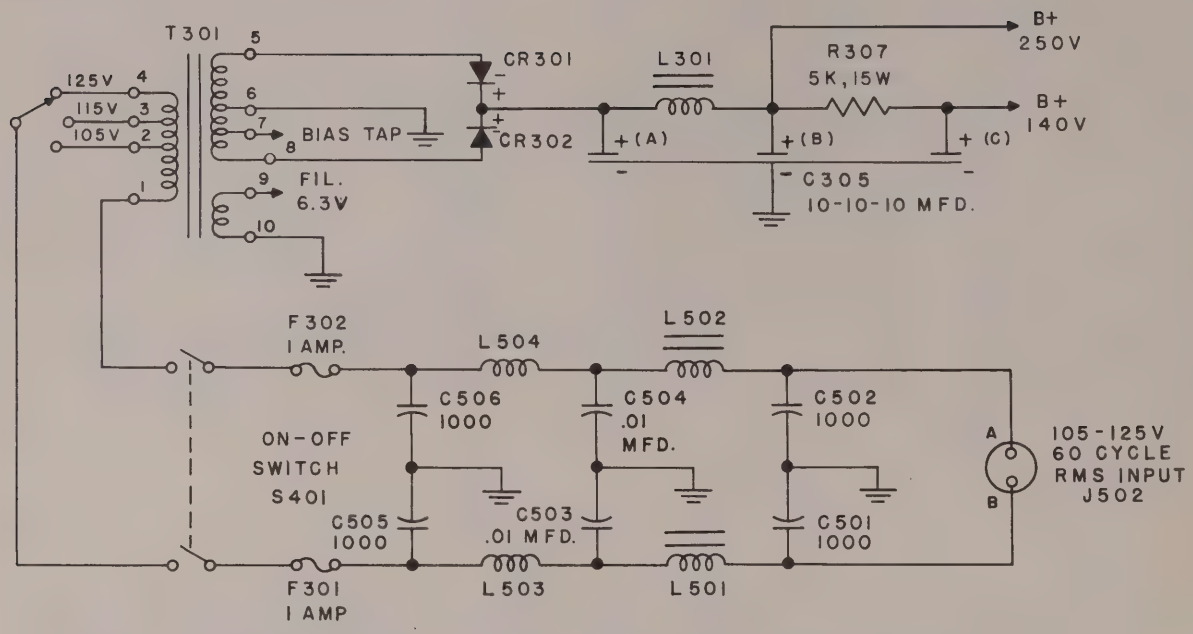


Figure 2-22. Simplified Schematic, High Voltage and Filament Supply

is isolated on one side of the line by two electrolytic capacitors (C511 and C512), which prevent a speaker from short circuiting the DC remote control voltages between the two sides of the line.

The head-telephone winding available on pin 7 and pin 8 is a low impedance winding of four ohms, and is designed for use with loads in excess of 250 ohms. This winding is connected to PHONES level control (R404) which can control the head-telephone level over a range of at least 30 db when 600 ohm headphones are used. The audio must pass through an RF filter section composed of C401, L401 and C402 before reaching the PHONES jack (J404). This filter and the filter in the high level output effectively keep undesired RF signals from entering the receiver through the audio lines to cause interference, and prevent oscillator and harmonic radiation from causing interference and detection on other receivers.

(2) POWER SUPPLY.—As shown in the simplified schematic, figure 2-22, the power supply consists of a full-wave rectifying system, using selenium rectifiers and provides for multi-tap selection of the AC voltage source. A two-pin POWER receptacle (J502), located on the rear compartment, provides connection to the AC power source. Both sides of the AC line pass through an RF filter system, located in the rear compartment. This filter is composed of two sections, the first section consisting of C501, C502, L501, L502, C503 and C504. This section will attenuate signals in the range of 200 Kc to 8 Mc. The second section, composed of L503, L504, C505 and C506 will attenuate signals above 8 Mc. Both sides of the AC line then pass through two fuses F301 and F302, which are 1 amp 3 AG slow-blow fuses. Slow-blow fuses are used to prevent current surges from opening the fuses if an intermittent connection is made to the power source. The AC line then passes through the double pole single throw POWER switch (S401) which is mounted on the front panel. The AC line then connects to the primary of the transformer T301 through a single pole three position switchable link which is mounted on TB301, located on the under side of the power supply chassis. This switch is used to select one of the three taps of the primary of T301, which are labeled 105 volts, 115 volts and 125 volts. The voltage of the AC power supply should be measured and the appropriate tap selected. The power transformer T301 has two secondaries, one of which supplies 6.3 volts AC to the filaments of all of the tubes in the receiver. The other winding is the high voltage winding which supplies approximately 225 volts rms AC to the selenium rectifiers CR301 and CR302, which are connected as a full-wave rectifier. The output of these rectifiers is smoothed by a capacitor input filter consisting of L301, R307 and C305 (A-B-C). C305 is a three section plug-in electrolytic capacitor. The fully filtered B+ output voltage, approximately 140 volts, supplies most of the

requirements of the receiver. B+ from the L301 and R307 junction furnishes approximately 240 to 250 volts to the audio output tube V302. The negative bias supply system is illustrated in figure 2-23. The AC voltage at terminal 7 of T301 is 75 volts rms with respect to ground. This bias tap is connected to half-wave selenium rectifier CR303. The bias capacitor-input filter is composed of C304, R306 and C303. As can be seen from figure 2-23, the —60 volt bias supply is connected to six different loads. Load 1, which consists of voltage divider R305 and R304, furnishes a negative voltage of —14 volts to the grid resistor of the V302 audio output tube. Load 2, consisting of R401, R405 and R402, permits an adjustable amount of negative bias to be connected to the stages controlled by the AGC bus, namely V101, V201 and V202 through the LOCAL-REMOTE (S403) and the RECEPTION switch (S301B). Load 3, which is connected through the RECEPTION switch (S301B) is applied at the discretion of the operator through SQUELCH test switch S402 and R229 to V206B squelch tube grid through the LOCAL contacts of the LOCAL-REMOTE switch (S403). R230 is a grid return resistor for the V203 squelch tube when the SQUELCH test switch S402 is inoperative. Load 4, consisting of R227 and R228, provides a negative voltage which is connected to the V206B cathode which effectively provides a positive grid bias for this tube. Load 5 consists of R218, R217 and the cathode-plate resistance of V204. Load 6 consists of R233, and R232 to ground in conjunction with a positive voltage supply network which provides a negative voltage of —0.9 volts to the grid of V203 and through isolation resistor R231 to the AGC bus, during A2-A3 operation, through the RECEPTION switch S403, and applies this voltage to V101, V201 and V202.

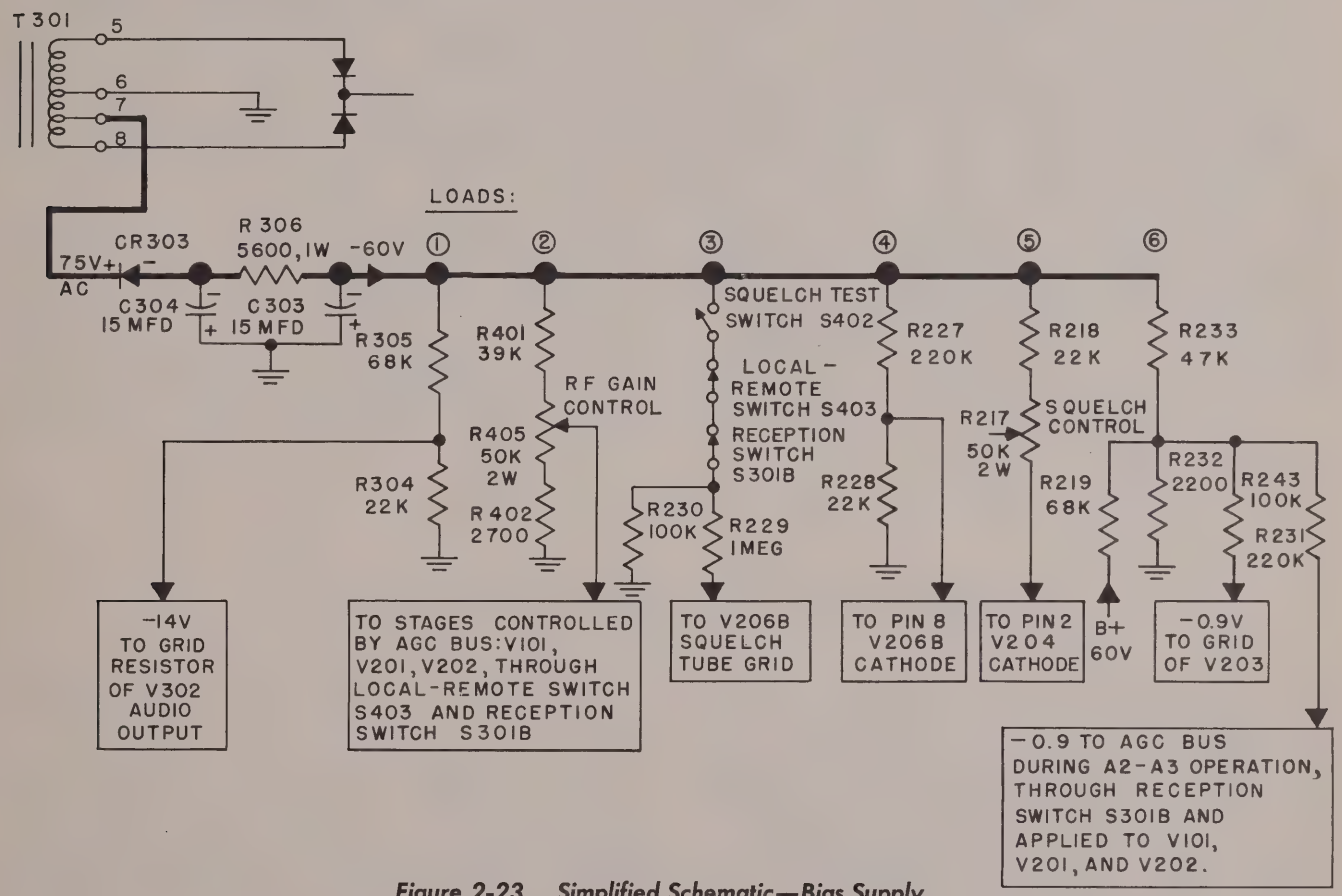


Figure 2-23. Simplified Schematic—Bias Supply

d. REMOTE CONTROL FUNCTIONS.—Figure 2-24 shows a schematic wiring diagram for the remote control connections. The high level output winding of audio output transformer T302, terminals 3, 4, 5 and 6, has its center tap effectively bypassed for AC by a triple section electrolytic capacitor C306. This capacitor permits the connection of DC control functions to pins 4 and 5 without grounding out these voltages. The audio present across the entire winding from terminals 3 to 6 is coupled through pins A and B of REMOTE receptacle (J503) over a remote line (telephone) to REMOTE isolation line transformer with a 1:1 transforma-

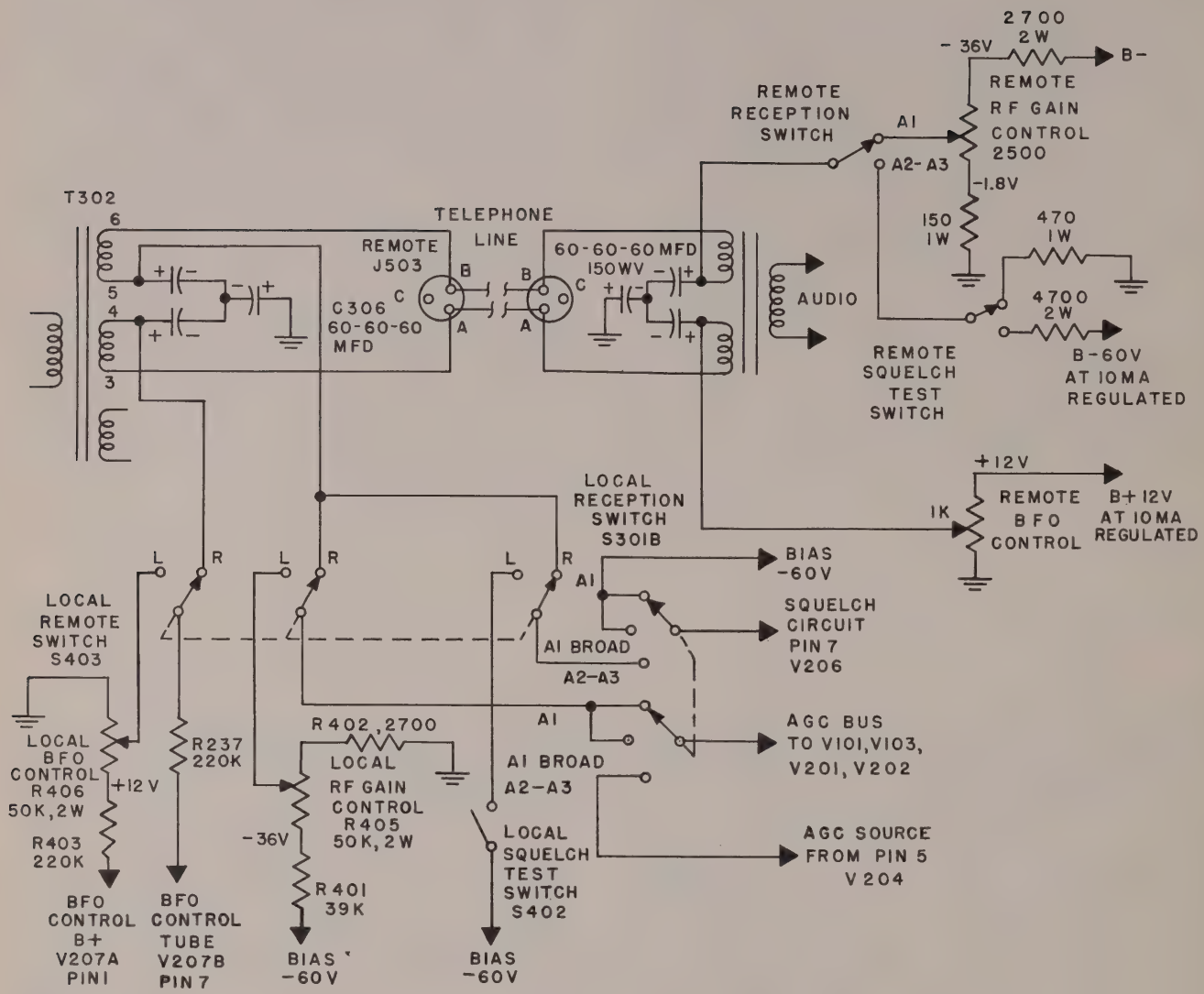


Figure 2-24. Simplified Schematic—Remote Connections

tion ratio and a split primary which duplicates winding 3, 4, 5 and 6 of T302. A low resistance ground must be connected from the grounded side of C306 in the AN/FRR-31 receiver to the common ground connection of the remote triple section electrolytic which is located at the primary center tap connections of the remote audio transformer. With the arrangement shown, the receiver BFO is controlled over one side of the telephone line and ground. On the other side of the telephone line and using the common ground, two circuits may be controlled at different times, depending on the position of RECEPTION switch (S301). The RF GAIN control is operative during A1 and A1 BROAD reception, and the SQUELCH test switch is operative for A2-A3 reception.

Additional audio loads may be connected to the AUDIO connector, the number, type and connections being determined by the audio outputs required at particular loads and the receiver specifications: 200 ohms minimum total load and 1.5 watts maximum rated output at 7% distortion. More than 1.5 watts total output may be obtained with a reduction in audio quality; likewise less audio output with poorer quality will be obtained with a total load of less than 200 ohms impedance. The total load is the impedance presented by the parallel circuit combination of the AUDIO and REMOTE load impedances.

$$\text{Total Load Impedance} = \frac{(\text{AUDIO Load ohms})\ (\ \text{REMOTE Load ohms})}{(\text{AUDIO Load ohms}) + (\text{REMOTE Load ohms})}$$

Example: If the REMOTE Load Impedance is 600 ohms and the AUDIO Load Impedance is 300 ohms, the total receiver load will be 200 ohms.

The remote BFO control should provide an adjustable voltage from 0 to +12 volts utilizing a potentiometer with the same taper as the local BFO control (R406). As can be seen from figure 2-24, the positive remote BFO control voltage is connected to the lower half of the remote transformer primary winding, through pin A of J503, through secondary winding 3-4 of T302 and thus to the REMOTE position of the LOCAL-REMOTE switch (S403). The local BFO control (R406) is connected to the LOCAL position of the LOCAL-REMOTE switch (S403). A remote RECEPTION switch must be provided so that either of the two control functions applied to the other side of the telephone line can be selected. Figure 2-24 indicates the remote RECEPTION switch. When switched to A1, it connects the RF gain control voltage from the remote RF GAIN control through the remote RECEPTION switch to the upper side of the telephone line. This function passes through pin B of J503 and through T302 winding 5-6 and is then connected to two REMOTE contacts of the LOCAL-REMOTE switch (S403). The local RF GAIN control (R405) is connected to a LOCAL contact of the LOCAL-REMOTE switch (S403). Therefore, either the local or remote RF GAIN controls can be selected to control the RF gain circuits of the receiver through RECEPTION switch S301B during A1 and A1 BROAD reception. The RF gain control voltages are applied to the AGC bus and thus to V101, V201 and V202 in order to control the over-all receiver gain. When the remote RECEPTION switch is set for A2-A3 reception, a negative voltage of 60 volts can be applied at the will of the operator through the remote SQUELCH test switch as indicated, and through a limiting resistor over the upper telephone line wire to the same two remote contacts of the LOCAL-REMOTE switch utilized by the remote RF GAIN control circuit. A negative voltage of —60 volts can be applied through the local SQUELCH test switch (S402) to the local position of the LOCAL-REMOTE switch (S403). As can be seen from figure 2-24, the V206B squelch tube grid can be connected through the A2-A3 position of the RECEPTION switch (S301B) to either the local or remote SQUELCH test switch.

The remote control unit, as generally described here, is not supplied as a part of the receiving set. For exact instructions concerning specific remote control units that might be used in conjunction with the receiving set, refer to their specific instruction books.

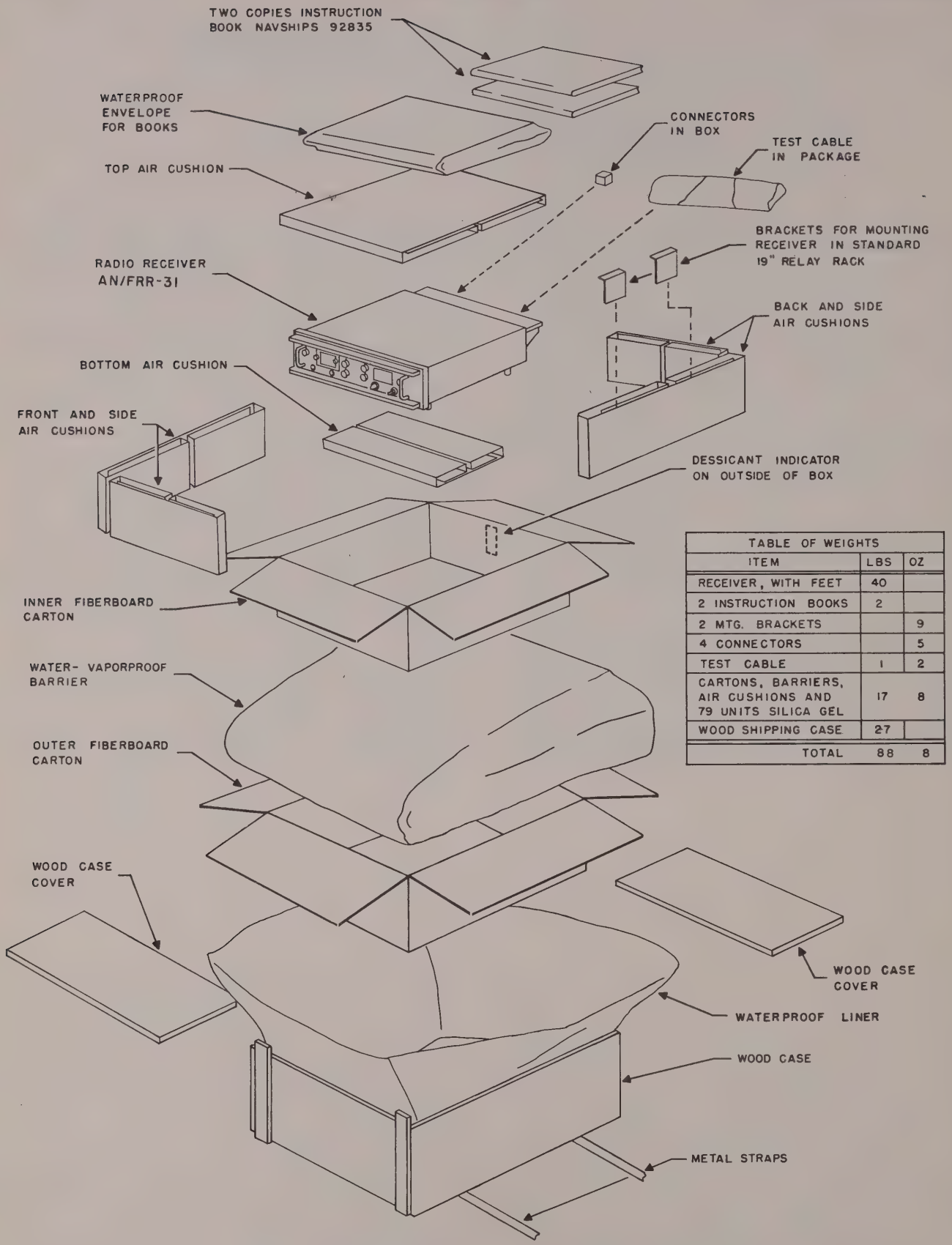


TABLE OF WEIGHTS		
ITEM	LBS	OZ
RECEIVER, WITH FEET	40	
2 INSTRUCTION BOOKS	2	
2 MTG. BRACKETS		9
4 CONNECTORS		5
TEST CABLE	1	2
CARTONS, BARRIERS, AIR CUSHIONS AND 79 UNITS SILICA GEL	17	8
WOOD SHIPPING CASE	27	
TOTAL	88	8

Figure 3-1. Method of Packing Radio Receiving Set AN/FRR-31

SECTION 3
INSTALLATION AND INITIAL ADJUSTMENTS

1. INSTALLATION DRAWINGS.

A list of illustrations which may be helpful for the installation of this equipment together with the contractor's drawing numbers and instruction book figure numbers is given in table 3-1.

TABLE 3-1. INSTALLATION DRAWINGS

ITEM NO.	SUBJECT OF DRAWINGS	COMCO DWG. NO.	INSTRUCTION BOOK FIGURE NO.
1.	Outline Drawing—Radio Receiver AN/FRR-31 including case, table or bench mounting feet; relay rack mounting brackets; rear compartment including receptacles and external connector plugs.	331-R-501	3-8
2.	Outline Drawing—Fabrication of coaxial transmission cable using AN type UG-21B/U plug.	326-R-414	3-6
3.	Outline Drawing—Fabrication of coaxial transmission cable using AN type UG-88/U plug.	326-R-412	3-7
4.	Photo illustration—Radio Receiver chassis assembly and disassembly.	326-R-863	3-4
5.	Over-all Schematic Diagram—Radio Receiver AN/FRR-31.	331-R-101	7-18
6.	Practical Wiring Diagrams—Radio Receiver AN/FRR-31.	331-R-401	7-19, 7-20
7.	Schematic Diagram—Remote Control Unit.	326-R-120	3-5

2. UNPACKING THE EQUIPMENT.

a. GENERAL.—Each complete Radio Receiving Set AN/FRR-31 is shipped in a single wooden box. The items comprising a complete AN/FRR-31 equipment are listed in table 1-1.

The method of packing the equipment is shown in figure 3-1. The receiver is separated from the walls of the fiber board carton by suitable fiber board air cushions. The two angle brackets, provided for use when the receiver is to be mounted in a relay rack, are inserted in the void of the side air cushion. The test cable (W601), which is used to connect the receiver chassis with the rear compartment, is packed under the rear compartment. Four connector plugs, provided for the fabrication of external audio, power, remote and antenna cables, are included in a separate box. Two copies of the instruction book, wrapped in a separate package, are packed on top of the top air cushion.

The inner carton is placed inside a second carton and separated from it by a moisture-vapor-proof barrier. The outer carton is placed inside the wooden box, separated from it by a waterproof box liner. The moisture-vapor-proof barrier is heat sealed at the time the equipment is sealed for shipment. To unpack the equipment proceed as follows:

1. Cut the two metal bands that bind the box; and remove the top panel of the box using a nail puller.
2. Cut and unfold the waterproof box liner.
3. Break sealing tape and open the outer fiberboard carton.
4. Remove from box and cut moisture-vapor-proof barrier between outer and inner carton.
5. Break sealing tape and open the inner fiberboard carton.
6. Lift out instruction books.
7. Lift out top fiberboard air cushion.
8. Remove relay rack mounting brackets from void space in the side air cushion.
9. Remove the air cushions.
10. Lift out receiving set, test cable and the box containing four connectors from under the set.

b. MECHANICAL CHECK.—The equipment should be inspected for possible damage or disarrangement during shipment. Check to see that no nuts, washers, bits of solder or other foreign particles have become lodged where they might cause a short circuit. Tighten any screws or nuts which may have worked loose. A careful search would also be made for broken wires and loose connections, since a detailed mechanical inspection at this time may save much inconvenience in the future. All mechanical controls on the front panel should be operated in each position, or through their full range of travel, in order to detect any bent shafts or other evidences of abnormal operation. Check to see that all tubes are undamaged and are firmly seated in their sockets; that all tube shields are firmly in place; that fuses F301 and F302 are in their holders (see figure 5-1) and a spare fuse is in place near them. Be sure that the plug-in electrolytic capacitor assemblies are properly seated in their octal sockets.

Special care should be given in checking the two clutches (E401, E402) on the front panel to ensure that they have not been damaged in any way. Extreme care must be taken in removing the IF or Audio/Power Supply chassis as the clutches must be correctly positioned for disengagement prior to attempting the removal of these chassis. Also when replacing these chassis the clutch must be properly positioned (E401 to S201 and E402 to S301) to engage the appropriate shafts. (see figure 3-2)

3. INSTALLATION

a. LOCATION OF EQUIPMENT.—In locating the receiver, consideration should be given to the accessibility of a 105, 115 or 125 volt, 50 to 60 cycle power source, the antenna transmission line, local and remote speakers lines, remote control units and any supplementary equipment to be employed. Clearances should be adequate for ventilation and to permit removal of the receiver chassis from the case. The unit should not be mounted operating exceeds the —15°C to +50°C range (+5°F to +122°F). When not operating, the receiver should not be kept in any location where the ambient temperature exceeds a range of —20°C to +55°C, (—4°F to +131°F). Provisions should be made to allow alignment and service of the chassis within the five foot limitation of the case receiver test cable (W601). Sufficient clearance should be available at the rear of the cabinet to provide access to the rear compartment and connecting cables.

b. TABLE OR BENCH MOUNTING.—The receiver is mounted by removing the chassis from the case, marking and drilling mounting holes on the table or bench, fastening the feet to the table and reinstalling the chassis in the case. First unscrew the four large slotted Simmons fastener screw heads, at the extreme corners of the front panel, one-quarter turn counterclockwise each. Then pull the chassis out until the latches on the sides prevent further movement. Press the side latches down with the thumbs while holding the chassis frame with the fingers and withdraw the chassis from the case. Remove the mounting feet and using the case as a template, mark the table with a scribe through the four mounting holes on 11 x 15⅞ inch centers and drill four 5/16 inch holes through the bench. Replace mounting feet.

Mount the case to the bench by four ¼-20 machine screws and lock washers inserted from the underside of the bench. Slide the chassis back into the case, pressing the latches to clear the chassis stops, and tighten the Simmons fasteners.

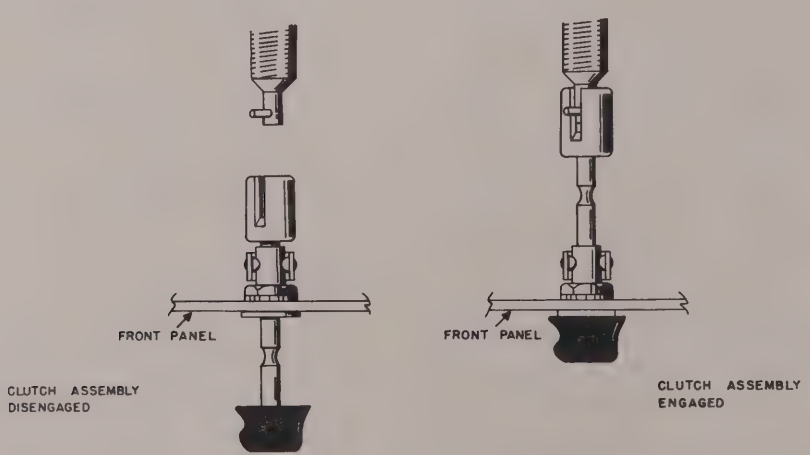


Figure 3-2. Control Knob Clutch Details

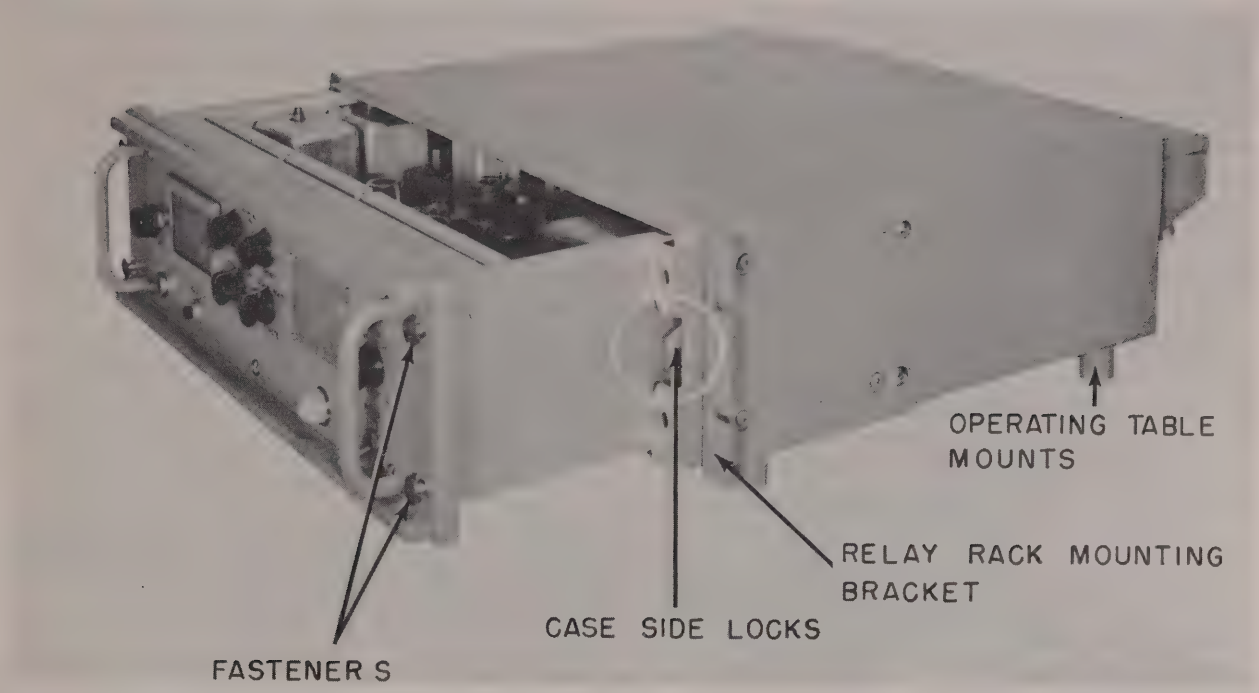


Figure 3-3. Relay Rack Mounting

c. RELAY RACK MOUNTING.—If the receiver is to be mounted on a standard relay rack, the table or bench mounting feet are not required and should be removed. Instead, attach the two angle mounting brackets to the sides of the cabinet. The angle brackets are symmetrical in shape and are attached, one to each side of the cabinet, by means of four No. 10-32 thread, 5/8 in. Phillips head machine screws. These screws are shipped, already threaded into tapped holes on each side of the cabinet. These screws are nickel plated; the other screws on the case are painted. Remove the eight nickel plated screws, line up the bracket with the tapped holes and replace the screws.

d. EXTERNAL CONNECTIONS.—All external connections are brought into the receiver through the rear compartment of the cabinet, except for the head-telephone jack. No connecting external cables are supplied with the AN/FRR-31 equipment, other than the 6 ft. ceptacles of the rear compartment are provided. A method of assembling the two coaxial antenna plugs and cables is shown in figures 3-6 and 3-7. The types and functions of all these plugs are summarized in table 3-2. A suitable earth ground should be available for connection to the rear compartment GND bolt.

TABLE 3-2. CONNECTORS SUPPLIED WITH AN/FRR-31 EQUIPMENT FOR MAKING EXTERNAL CONNECTIONS

PLUG SYMBOL	MATING RECEPTACLE SYMBOL	MATING RECEPTACLE TITLE	CIRCUIT IN WHICH USED	PLUG TYPE
P501	J501	72 OHM ANT	72 ohm antenna input	AN type UG-21B/U
P502	J502	AC POWER	105, 115, 125 v; 50-60 cycle power imput	AN3106A-10SL-4S
P503	J503	REMOTE	Remote Control	AN3106A-10SL-3S
P504	J505	AUDIO	Audio Output	AN3106A-10SL-3S

e. PREPARATION FOR OPERATION.

(1) AC INPUT.—The AC power input enters the receiver rear compartment through connectors P502 (plug) and J502 (receptacle). After passing through a low pass filter, which attenuates all frequencies between 2 and 200 Mc, the two leads pass from the rear compartment to the Audio/Power Supply chassis through connectors J504 and J302. This latter connection is made when the receiver chassis slides into its case and J302 of the chassis engages J504 of the rear compartment. Before connecting the external AC cable to the power source, remove the receiver chassis, and check that fuses F301 and F302 (1 amp. 250 volt type 3 AG slow blow) are in their respective fuseholders on top of the Audio/-Power Supply chassis. Next, measure the AC line voltage. Locate the AC switching terminal board (TB301) on the bottom of the Audio/Power Supply chassis, loosen the screws holding the switchable link and place the slotted end of this link under the screw head which most closely matches the available voltage. This procedure serves to match the proper tap of the power transformer (T301) primary winding with the line voltage. Tighten all screws on the terminal board.

(2) AUDIO OUTPUT.—Receptacles are provided on the receiver rear compartment to feed the audio output to a local and/or remote speaker (or head-telephone). Both sides of the line pass through filters in the rear compartment which attenuate all frequencies between 2 Mc and 200 Mc. The output transformer (T302) has two secondary windings. One 600 ohm winding permits a portion of the audio output to be fed to the PHONES jack (J404) on the front panel. The second winding, which is 300 ohms, provides audio output for the local and/or remote speakers, and connects to receptacle J302. By the use of inverse feedback in the output circuit, the load across this winding may vary from 200 to 600 ohms, with negligible change of audio output. The audio level for the remote as well as the local speaker is regulated by the AF LEVEL control (R301), but if additional control of this level is desired at the remote point, a 600 ohm T-pad may be installed to provide the necessary variation.

(3) 72 OHM ANTENNA INPUT.—The antenna input enters the receiver through the coaxial connectors P501 and J501. In the rear compartment, a short length of coaxial transmission line permanently connects J501 to J504. The latter connector engages J302 of the Receiver Audio/Power Supply chassis. A short length of coaxial line, permanently connected to the antenna terminal of J302, bridges between the Audio/Power Supply chassis and the RF chassis. A bayonet type plug (P301: UG-88/U) provides connection to the RF antenna receptacle (J102). All of these connections should be checked, prior to placing the equipment into operation, to be sure of proper continuity.

(4) CRYSTALS.—The AN/FRR-31 receiver requires two crystals of the same type, CR-18/U. One, Y101, mixes with the incoming signal frequency to produce a 2020 Kc IF signal. As this receiver is a single channel crystal controlled type, it is necessary that this frequency determining crystal be changed each time a different frequency is to be received. Also each time this crystal is changed it is necessary to retune the four RF amplifier coils (Z101,Z102,Z103 and Z104).

Complete instructions for determining the proper crystal frequency and alignment of the above coils are given in SECTION 7, paragraph 4.f.

The second crystal is also a CR-18/U type. This 1900 Kc crystal oscillator, whose output, beating against the 2020 Kc signal, creates a frequency of 120 Kc. Check to see that this crystal is firmly in place.

The receiver operating frequency should be marked on the plastic card on the front panel with ink or pencil. The transparent plastic card material permits easy erasure of any marking. A more permanent frequency indication on a card can be inserted behind the transparent plastic by removing the thumb screws.

(5) CHASSIS ASSEMBLY AND DISASSEMBLY.—The AN/FRR-31 equipment comprises a cabinet with a rear compartment mounted on the case, a chassis-frame assembly, which includes the front panel and three chassis assemblies designed to operate as complete functional units, fabricated so that any or all of the three may be removed or replaced without unsoldering any leads. Connections between units are made through plug-in connector assemblies mounted on the frame shelf. This arrangement permits removal of defective assemblies and replacement by non-technical personnel. These chassis are removed by first unscrewing the four hold-down screws, one in each corner on the top of the chassis; disengaging the two clutches of the RECEPTION and SELECTIVITY switches on the front panel; and disconnecting the coaxial cable between the RF and Audio/Power Supply chassis. The units can then be pulled up and out of the frame assembly. The replacement is accomplished by reversing the above procedure.

4. INITIAL ADJUSTMENTS AND PERFORMANCE TESTS.

When the alignments, installation and antenna installation have been completed, and all the checks made as outlined, in the previous paragraphs, the receiver is ready for its initial operation adjustments. For complete information concerning the panel and chassis controls

functions, locations, settings and operation consult SECTION 4. Then proceed as follows:

a. LOCAL OPERATION.

(1) Pull the receiver out of the case and connect the two with the test cable (W601).

(2) The LOCAL-REMOTE switch (S403) allows the selection of either local or remote operation as the situation may require. Place this switch in the LOCAL position.

(3) The RECEPTION switch (S301) allows the selection of three modes of reception: (a) A1—reception of telegraphy without the use of modulating audio frequencies, through a 1000 cycle pass filter to reduce noise and unwanted signals. (b) A1-BROAD—reception of telegraphy without the 1000 cycle filter. (c) A2-A3 reception of telephony and of telegraphy by keying of the modulating audio frequencies. Select the particular mode desired.

(4) The SELECTIVITY switch (S201) permits selection of either SHARP IF selectivity (usually used for A1 or A1 BROAD reception) or BROAD IF selectvity (usually used for A2-A3). Set to BROAD.

(5) Throw the POWER switch (S401) ON and observe that the panel indicator lamp is on. Allow equipment to warm up for two or three minutes. As it warms, noise may or may not be heard in the speaker depending on the setting of the SQUELCH threshold control (R217). For initial purposes the SQUELCH should be open (fully counterclockwise) and the NOISE LIMITER switch (S202) OFF.

(6) During A2-A3 operation, if no noise or signal is heard, press the SQUELCH test button (S402) on the front panel. A hiss or rushing signal should be heard in the speaker indicating that the receiver and the squelch circuit are operating. Check the PHONES control operation with a head-telephone plugged into J404 while listening to the noise.

(7) Set the SELECTIVITY switch to SHARP and repeat the squelch test. Hearing receiver noise will indicate that the IF stages also function in SHARP SELECTIVITY operation.

(8) Set the RECEPTION switch to A1 BROAD; receiver noise will be heard.

(9) Vary the RF GAIN control; this should vary the receiver noise output.

(10) If an A1, A2 or A3 signal is heard, varying the BFO control will change the beat note frequency; zero beat should occur at about 50 per cent rotation.

(11) Set the RECEPTION switch to A1. The receiver noise level will be lower and sound thinner due to the switching in of a 1000 cps band pass filter. To hear an incoming signal, the BFO control must be adjusted to change the beat frequency to about 1000 cps which will then pass through the filter. The 1000 cps can be obtained at about either 25 per cent or 75 per cent rotation of the BFO control. Return the SELECTIVITY switch to BROAD and the RECEPTION switch to A2-A3.

(12) When a transmitted signal is heard, adjust the AF LEVEL control (R301) for the desired audio level in the local speaker. Note that, with this control at maximum (clockwise) and a 200 to 600 ohm load on the receiver, a strong input signal will produce an audio output in excess of two watts, with high percentage of distortion. Therefore, it is desirable to keep this control below 70 per cent rotation which will give audio output levels of approximately 1 to 1.5 watts, with low distortion on the average signal. This AF LEVEL control is also used to adjust the audio level when the equipment is connected to a remote audio load. By the use of inverse feedback in the audio output circuit, it is possible to use one or more speakers simultaneously, without more than two db change in output level, provided the total load remains within 200 to 600 ohms. Since in A1 or A1 BROAD reception the AF LEVEL control determines the signal and noise clipping level, it is important not to set the clipping level too low. To do so will increase the relative amount of noise received compared to the signal. At an extremely low setting the noise and signal will have the same amplitude.

(13) Check the NOISE LIMITER switch (S202) by switching it ON and OFF. Usually this switch is ON and in this position, limits or clips all output from the detector in excess of 60 per cent modulation, particularly all noise peaks exceeding this level. It is especially effective on sharp pulsed noise with low repetition rates. When the NOISE LIMITER is switched ON or OFF, the audio power changes approximately 1 to 1.5 db. The switch is thrown to the OFF position for all alignments.

(14) The SQUELCH threshold control (R217) adjustment will be dependent upon the conditions under which the receiver will operate. It is operable only on A2-A3 reception. This control permits adjustment of the squelch threshold between the limits of approximately 1 to 100 microvolts. When set to the maximum counterclockwise position, the receiver may be unsquelched and

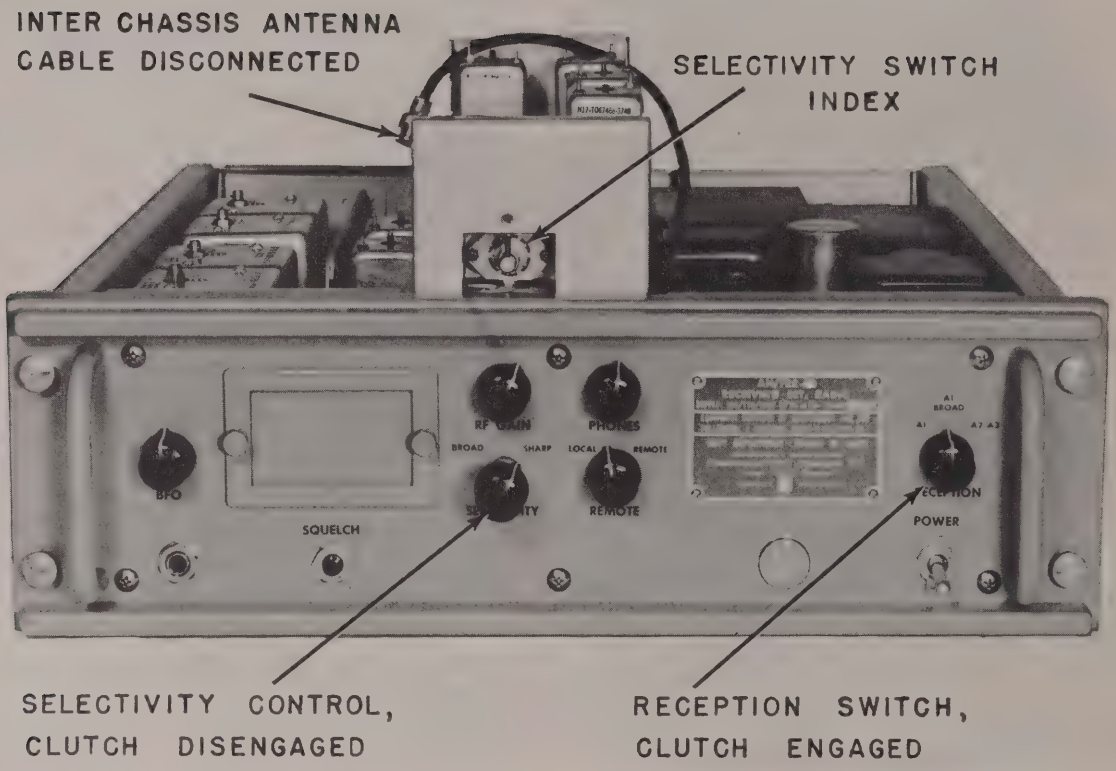


Figure 3-4. Receiver Chassis Assembly, Dis-assembly

noise should be present in the speaker or head-telephones when no transmitter signal is present. As the control is rotated in a clockwise direction, a point will be reached where the squelch will close and no audio will be heard in the absence of a transmitter signal. When the control is left at this point which is its most sensitive setting, the signal strength required to open the squelch will be approximately 1.4 microvolts or less. If the control is set at the maximum clockwise rotation, the signal required to open the squelch will be over 100 microvolts. For the best operation, the SQUELCH should be adjusted to the point where the receiver is just quiet and remains so under ambient noise conditions. Should a more sensitive setting be desired, the control may be retarded until occasional noise pulses are heard. If the receiver is operated close to the transmitter, and quietness of operation is desired rather than high sensitivity, the SQUELCH may be advanced clockwise past its sensitive point, so that weaker signals will not trigger the action and only the desired stronger signals will come through.

b. REMOTE OPERATION.—The receiver should be set for LOCAL and then be switched over to the REMOTE position. There should be no change in receiver operation as determined by monitoring. It is necessary to remember that in remote operation the remote RF GAIN and BFO controls are operative only when the set is receiving either A1 or A1 BROAD, while the SQUELCH test is operative only when the set is in the A2-A3 position. Check that the local RF GAIN and BFO controls (A1 or A1 BROAD reception) and the local SQUELCH test button (A2-A3 reception) are inoperative.

c. This completes the initial adjustments and the receiver is ready for regular operation, after being put back into the case. If during any of the previous adjustments, it appears that the equipment is not performing properly, it is advisable to make the suitable audio or sensitivity check, as outlined in SECTION 7. If these checks indicate some malfunctioning, corrective measures should be taken as described in SECTION 7.

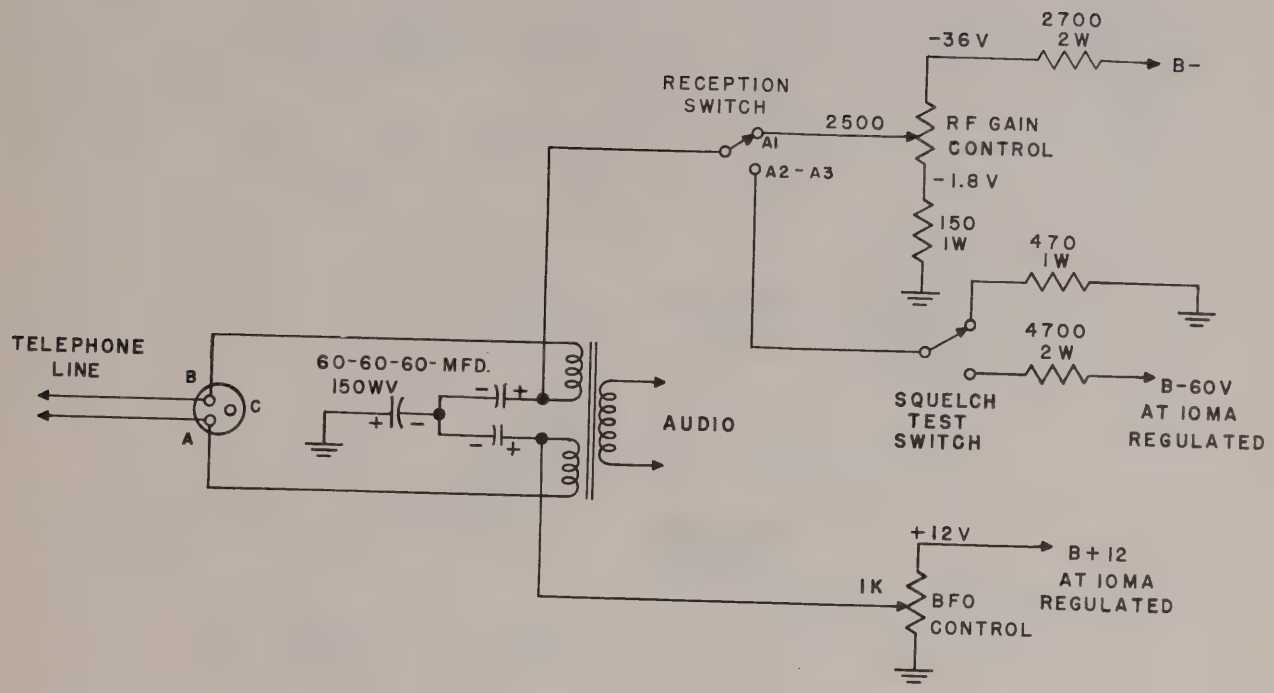


Figure 3-5. Schematic—Typical Remote Control Unit

5. REMOTE CONTROL UNIT SPECIFICATIONS

The AN/FRR-31, to function properly from a remote point, must be operated by a remote control unit fulfilling the requirements below as part of its specifications. A typical remote control unit is shown in figure 3-5 to illustrate the requirements. No such unit is furnished with the equipment.

a. TERMINALS OR CONNECTORS.

(1) AF INPUT (by telephone line or two wire conductor):

(a) BFO control-AF line from receiver J503, pin A.

(b) RF GAIN-SQUELCH-AF line from receiver J503, pin B.

(c) GROUND (earth or system ground or preferably line from receiver).

(2) POWER INPUT—as required by the remote unit.

(3) AF OUTPUT to speaker or head-telephones—as required for the installation or remote unit.

b. AF INPUT CIRCUIT AND IMPEDANCES.—The AF input transformer must have an input impedance within the range of 200 to 600 ohms with a split winding primary. The primary halves are isolated by capacitors (see figure 3-5). The load must have a continuous rating of 2 watts.

c. OUTPUT VOLTAGES (to be sent to the receiver).

(1) BFO control— 0.0V to +12 V at 10 Ma.

(2) RF GAIN— —1.8 to —30 V at 10 ma.

Both voltage sources must be regulated.

d. PANEL CONTROLS.

(1) RF GAIN potentiometer with a linear taper to vary the outgoing RF GAIN bias voltage from —1.8 V to —30 V. Panel marked: "RF GAIN".

(2) BFO potentiometer with a linear taper to vary the outgoing BFO controlling voltage from 0.0 V to +12 V. Panel marked: "BFO".

(3) RECEPTION switch—2 section, 3 pole, 3 position. Panel marked: "A1" (position 1), "A1 BROAD" (position 2), "A2-A3" (position 3) and "RECEPTION".

(4) SQUELCH test switch—single "make" type, momentarily normally open; panel marked: "SQUELCH" under switch; switch handle is normally up, if not a push button switch.

(5) AF VOLUME or PHONES control—to suit the remote circuit and level requirements.

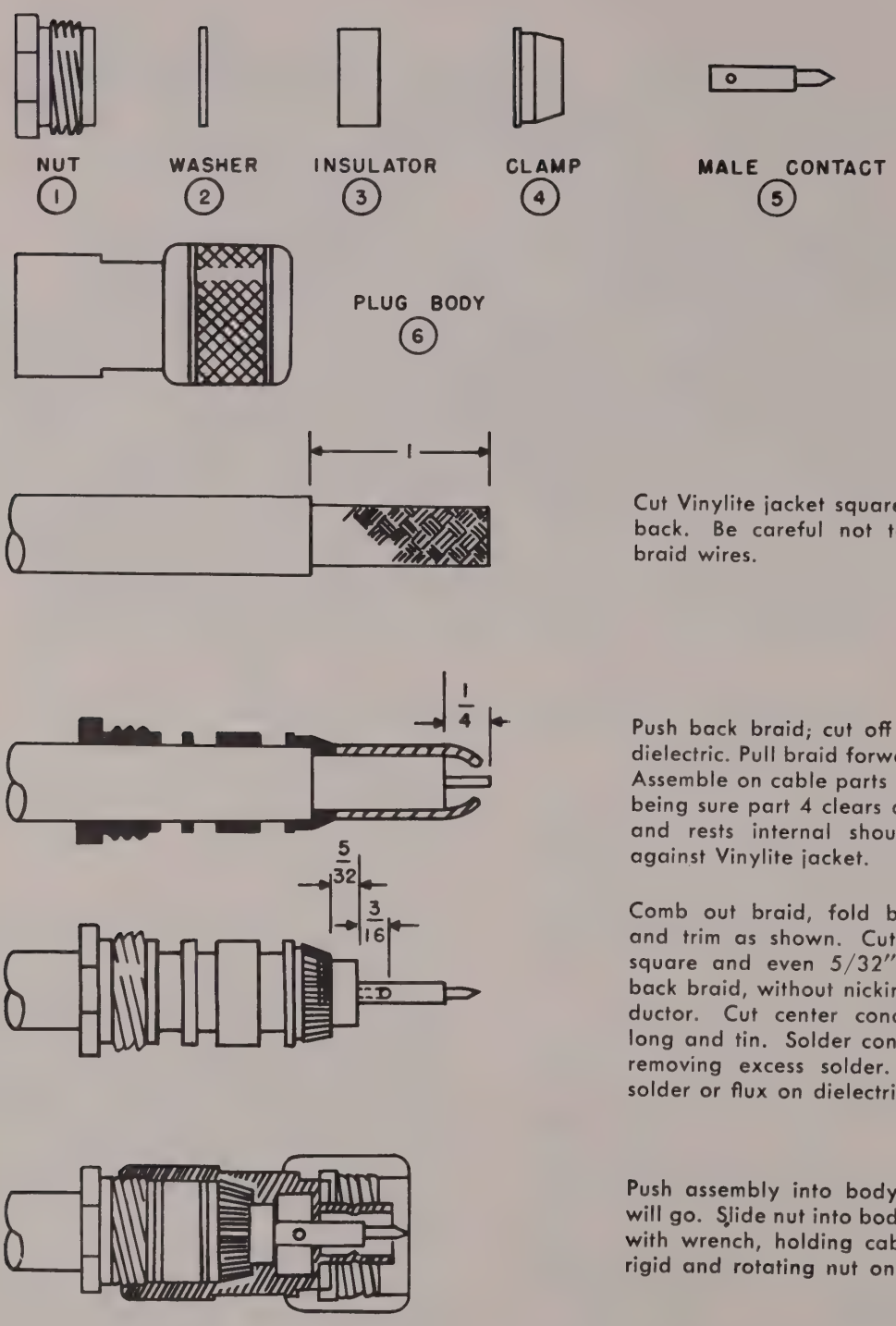
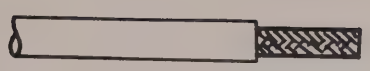

NUT
1
WASHER
2
INSULATOR
3
CLAMP
4
MALE CONTACT
5
PLUG BODY
6
1
Cut Vinylite jacket square and even 1" back. Be careful not to nick or cut braid wires.
1/4
Push back braid; cut off 1/4" of cable dielectric. Pull braid forward and taper. Assemble on cable parts 1, 2, 3 and 4, being sure part 4 clears all braid wires and rests internal shoulder squarely against Vinylite jacket.
5/32
3/16
D
Comb out braid, fold back smoothly and trim as shown. Cut off dielectric square and even 5/32" from folded back braid, without nicking center conductor. Cut center conductor 3/16" long and tin. Solder contact in place, removing excess solder. Do not get solder or flux on dielectric.
Push assembly into body as far as it will go. Slide nut into body and tighten with wrench, holding cable and body rigid and rotating nut only.

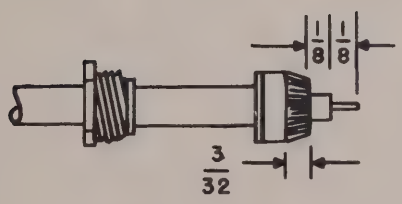
Figure 3-6. Method of Assembling AN Type UG-21 B/U Plug to JAN Type RG-11/U or Equivalent Transmission Line



Trim jacket ¼" for RG-58A/U,5/16" for RG-59/U or 7/16" for RG-71/U.

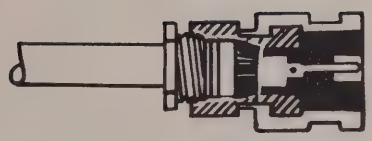
Fray shield and strip inner dielectric ⅛". Tin center conductor.

Taper braid and slide nut, washer, gasket and clamp over braid. Clamp must rest inner shoulder squarely against end of cable jacket.



With clamp in place, comb out braid, fold back smoothly and trim as shown, 3/32" from end.

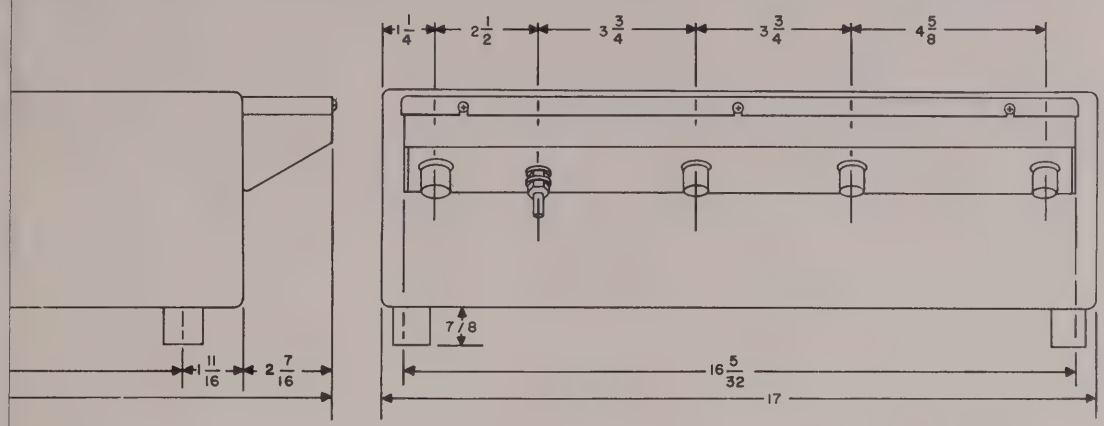
Slip contact in place, butt against dielectric and solder. Remove excess solder from outside of contact. Be sure cable dielectric is not heated excessively and swollen so as to prevent dielectric from entering into connector body.

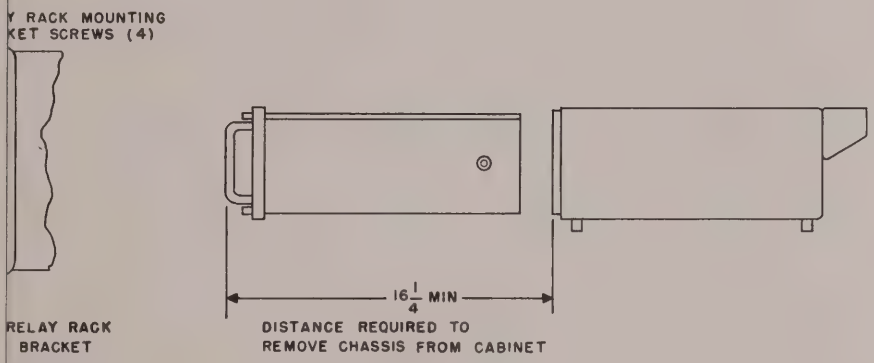


Push assembly into body as far as it will go. Slide nut into body and screw in place with wrench until tight, holding cable and shell rigid and rotating nut.

Figure 3-7. Method of Assembling AN Type UG-88/U Plug to JAN Type RG-58 A/U Transmission Line

NOTES





52 WATTS

52 WATTS

Figure 3-8. Outline, Radio Receiver, Panel, Case, Relay Rack Mtg Brackets, Operating Table Mounting Feet

NOTES

AN/FRR-31
INSTALLATION

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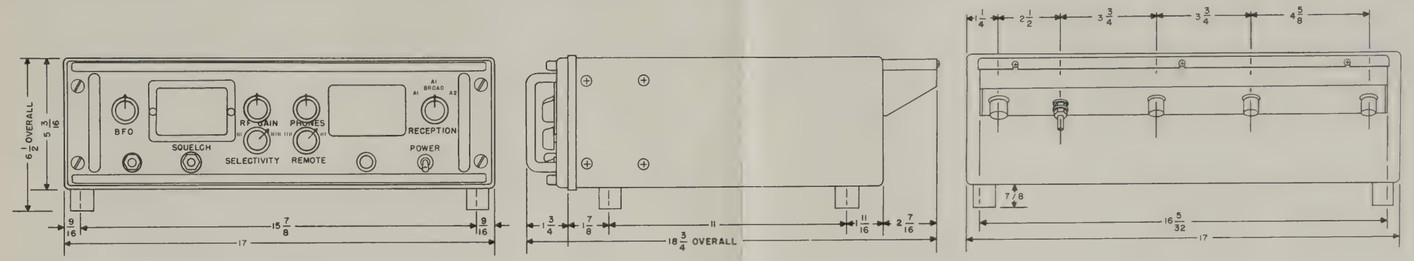
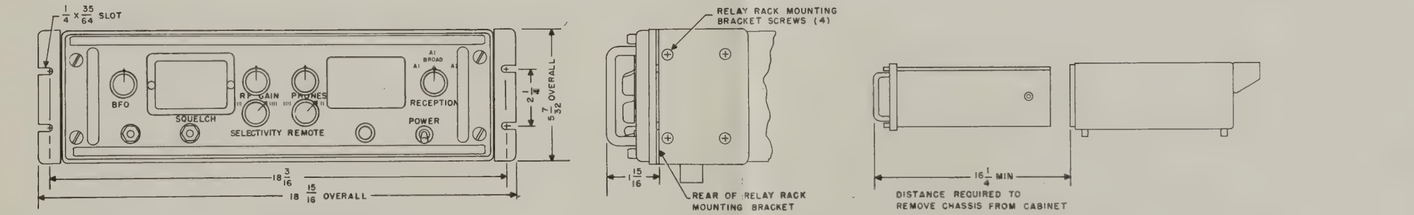
Section 3





NOTE:

RECEIVER IS SUPPLIED WITH MOUNTING LEGS (MOUNTED TO CABINET) FOR OPERATING TABLE MOUNTING.

RECEIVER IS SUPPLIED WITH RELAY RACK MOUNTING BRACKETS (ENCLOSED SEPARATELY) FOR RELAY RACK MOUNTING. BRACKETS ARE FASTENED TO SIDES OF CABINET USING SCREWS ALREADY ATTACHED TO CABINET. MOUNTING LEGS ARE REMOVED.

WEIGHT 40 POUNDS

POWER REQUIRED 62 WATTS

HEAT DISSIPATION 62 WATTS

Figure 3-8. Outline, Radio Receiver, Panel, Case, Relay Rack Mtg Brackets, Operating Table Mounting Feet

SECTION 4
OPERATION

1. INTRODUCTION.

The AN/FRR-31 single channel receiver is a crystal controlled single conversion superheterodyne receiver, designed for reception of telegraphy, without the use of modulating audio frequencies in the A1 and A1 BROAD positions; telegraphy by the keying of modulating audio frequencies and telephony in the A2-A3 position of operation over an 8-32 Mc frequency range. It comprises an RF amplifier, a frequency determining oscillator, a mixer, a three stage IF amplifier, a detector, three stages of audio amplification, a broad or sharp band selectivity switch, a 1000 cycle filter in the A-1 mode for sharp audio selectivity, a multiple impedance output with provisions for local and/or remote speakers (or head-telephones) and a local-remote control which allows the operation of the BFO, RF gain and the squelch test from a remote position. Special circuits provide noise limiting, automatic gain control, BFO frequency control, output limiting which controls the maximum amount of audio amplitude for A1 reception, and the squelch control. The receiver is designed for continuous operation over long periods of time with a minimum of attention.

2. PRELIMINARY.

a. It is assumed that, before being assigned to the operating personnel, the AN/FRR-31 equipment will have been installed and all the necessary adjustments made according to the instructions given in SECTION 3. These adjustments include the setting of the SQUELCH, NOISE LIMITER and AF LEVEL controls. For the benefit of operators who are technically qualified, the following paragraphs include instructions for proper adjustment of these chassis controls. It will be noted that because this receiver is of single channel design, a change in operating frequency requires a change in the Frequency Determining Crystal (Y101) and realignment of the frequency determining stages. This realignment will require special test equipment and should be performed only by qualified technicians in accordance with the instruction of SECTION 7. In changing over from local to remote or remote to local operation, readjustment of the audio level may be necessary. For this operation it is necessary to remove the receiver from its case.

b. Special care should be given to the clutches (E401 at the RECEPTION switch and E402 at the SELECTIVITY switch) behind the front panel. Extreme care must be maintained so that they do not become damaged. It must be remembered that they must be disengaged prior to removing either the IF or the Audio/Power Supply chassis, and they must be re-engaged when the chassis are re-inserted in the Panel-Frame assembly.

3. DESCRIPTION AND LOCATION OF CONTROLS.

a. FRONT PANEL CONTROLS.—These controls are used for turning the receiver ON or OFF; controlling the audio output to the head-telephones; squelch testing; selecting the mode of reception; receiver selectivity, local or remote operation and A1 reception tone. Their locations are indicated in figure 4-1.

(1) BFO CONTROL.—This control (R406) functions only when the receiver is operating on A1 or A1 BROAD. It varies the frequency of the BFO oscillator over a range of approximately 4000 cycles. This control should be at zero beat at approximately 50% rotation. The BFO transformer (T205) with an on-frequency signal near 50% rotation of the BFO control should give a beat note adjustment of approximately ±1500 cycles.

(2) HEAD-TELEPHONE JACK.—This jack (J404) is provided for listening with 500 to 600 ohm head-telephones. When the PHONES level control (R404) is set at maximum level (clockwise), the output from the head-telephone jack will be about one percent of the power delivered to the AUDIO receptacle when its load is 600 ohms. Accordingly when the receiver is delivering 1.5 watts into a 600 ohm load, the maximum audio available at the head-telephone jack is 15 milliwatts into 600 ohm phones. Low impedance speakers and head-telephones below 300 ohms should not be plugged into this receptacle.

(3) SQUELCH TEST SWITCH.—This is a momentary operated push button switch (S402), used to disable the receiver squelch or to receive signals which are too weak to open the squelch. This switch is only operative in the A2-A3 position. The switch is normally open. If the SQUELCH threshold control (R217) has been adjusted to a point where the squelch is always open, the squelch test switch will have no effect.

(4) RF GAIN.—When the receiver is operating on either A1 or A1 BROAD positions, this control (R405) is operative and applies an adjustable amount of negative voltage to the AGC line which can vary the receiver gain over 100 db.

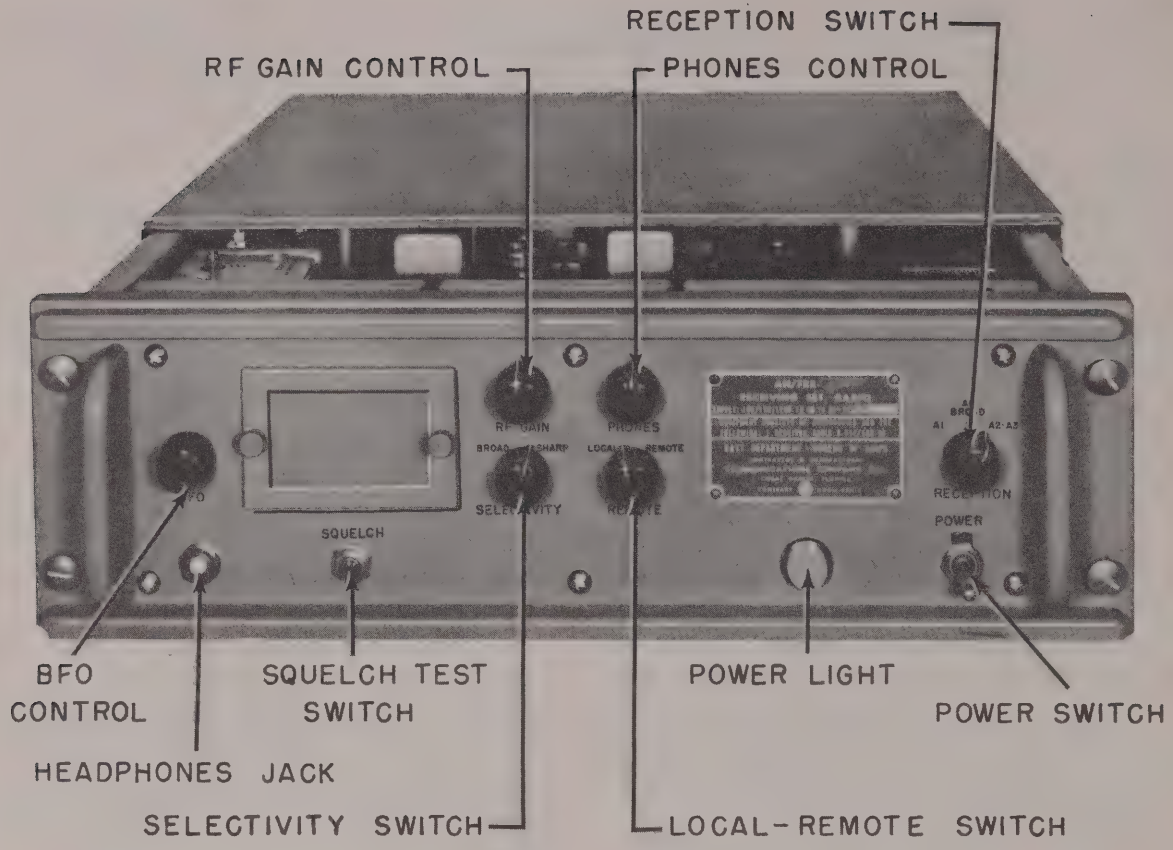


Figure 4-1. Front View of the Front Panel

(5) SELECTIVITY.—This control (S201), which is operative on all modes of reception, permits the changing of the IF from BROAD to SHARP selectivity as required. The band width of the SHARP position is approximately 2 Kc, and the width of the BROAD position is approximately 8-9 Kc.

(6) HEAD-TELEPHONE CONTROL.—This control, operative on all modes of reception, is used to adjust the audio level at the PHONES jack (J404). When 600 ohm phones are used, the level can be controlled in a range of at least 30 db. The head-telephone level is increased when the control is turned in a clockwise direction.

(7) LOCAL-REMOTE SWITCH.—This switch (S403) permits the selection of either local or remote operation. When the remote method is selected, it allows the remote operator to control the receiver BFO and RF GAIN and to test the squelch circuit from a distant point. The BFO and RF GAIN are controllable when the set is in the A1 or A1 BROAD position. The SQUELCH TEST and SQUELCH controls are operable only when the set is in the A2-A3 position.

(8) POWER INDICATOR LAMP (I401).—This is a neon indicator lamp which is operated from the B+ voltage supply of the receiver and indicates that the receiver is turned ON and the B+ supply is functioning.

(9) RECEPTION SWITCH (S301).—This control selects the desired mode of operation either A1, A1 BROAD or A2-A3. Table 4-1 shows the difference in circuit and control functioning in each mode.

(10) POWER SWITCH.—This DPDT switch (S401) controls the AC power input to the receiver. It is ON in the upwards position.

b. CHASSIS CONTROLS.—These controls, located on the RF, IF and Audio/Power Supply chassis as indicated in Figure 4-3 permit adjustment of various receiver functions and should not require readjustment after the initial installation, unless a change in operating conditions is required. These changes should be performed only by qualified personnel.

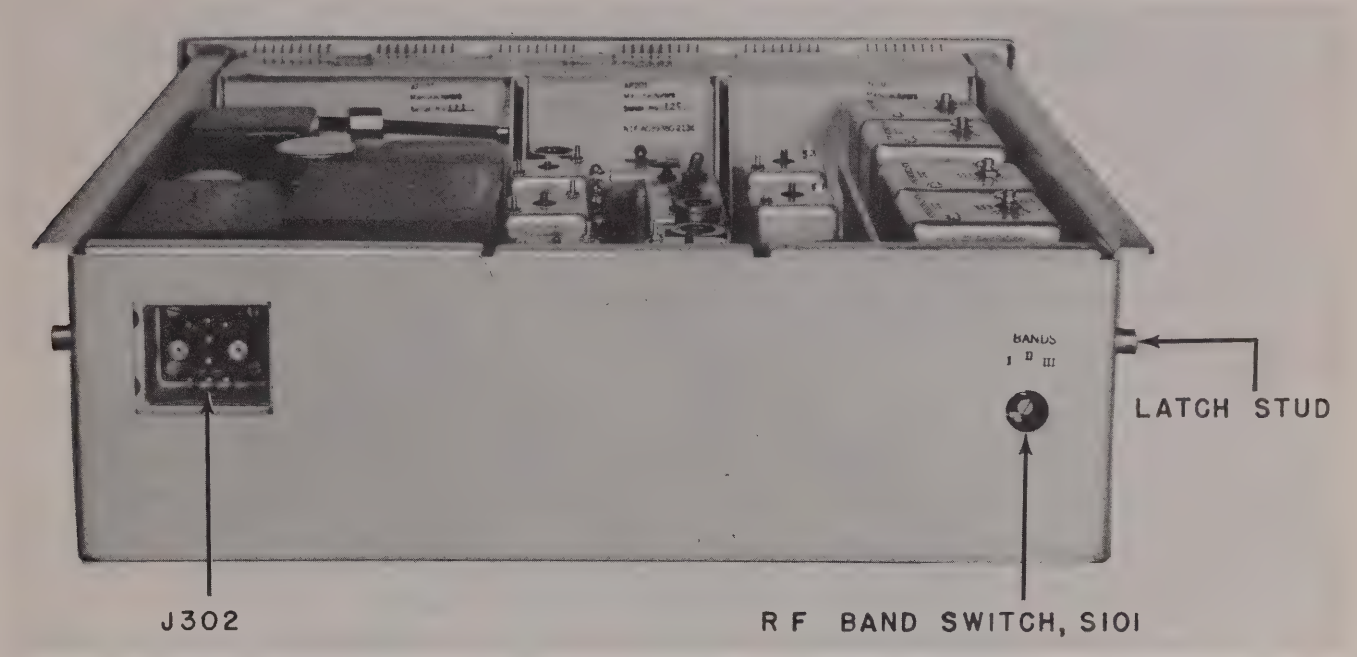


Figure 4-2. Rear View of the Chassis in the Wraparound Showing Connector and Band Switch

(1) NOISE LIMITER SWITCH (S202).—This switch is located on top of the IF chassis and is used to turn the noise limiter action ON or OFF, as desired. Normally the switch is ON, and in this position, it limits or clips all output from the detector in excess of 60% modulation, particularly all noise peaks exceeding this level. It is designed for A2-A3 reception, but may be switched on at any time. When the noise limiter is switched, the audio output power will change about 1 to 1.5 db.

(2) SQUELCH THRESHOLD CONTROL (R217).—This control, which is operative only on A2-A3 reception, located on top of the IF chassis, permits the adjustment of the squelch threshold. When the control is retarded to the maximum counterclockwise position, the receiver should be unsquelched and noise should be heard when there is no signal present. If the control is rotated in a clockwise direction, a point (approximately 10% to 20% rotation) will be reached where the squelch will close and no audio will be heard, providing no signal is present. When the control is left at the point where the SQUELCH has just closed, and the receiver is quiet, it will be at its most sensitive setting. If the control is advanced further clockwise, an increasingly stronger signal is required to open the SQUELCH making the receiver less sensitive but more adaptable to operation with strong desired signals or in an area of excessive noise.

(3) AF LEVEL CONTROL (R301B).—This control is one section of a dual potentiometer mounted on the Audio/Power Supply chassis and is used to adjust the audio level to all the receiver outputs, including the AUDIO (J505) and REMOTE (J503) receptacles and the panel head-telephone jack (J404). It operates only on A2-A3 reception. With this control set at maximum clockwise and a proper load on the receiver, the output produced by a strong signal will be in excess of two watts with a high percentage of distortion. This is due to the reserve of audio gain available for very weak signal use. It is desirable, therefore, to keep this control below 70 per cent rotation to keep distortion at a minimum.

(4) AF LEVEL CONTROL (R301A).—This control is part of a dual potentiometer and functions only during A1 or A1 BROAD operation. It controls the maximum audio amplitude which is heard over the head-telephone or speaker by varying the operation of the audio limiter circuit. The audio output will not exceed a set level, regardless of the variation of strength of the incoming signal.

(5) FREQUENCY BAND SWITCH (S101).—This switch is accessible only from the rear of the RF chassis by an access hole in the frame back after the receiver has been removed from its case. It selects the desired frequency band, Band I: 8-16 Mc; Band II: 16-24 Mc; Band III: 24-32 Mc.

TABLE 4-1. CONTROL FUNCTIONS

CIRCUIT OR CONTROL	A1	A1 BROAD	A2-A3
RF GAIN Control	Active	Active	Inactive
AGC Circuit	Inactive	Inactive	Active
Output Limiter Circuit	Active	Active	Inactive
AF Level Control (Section A)	Active	Active	Inactive
AF Level Control (Section B)	Inactive	Inactive	Active
BFO Circuit	Active	Active	Inactive
BFO Frequency Control	Active	Active	Inactive
1000 Cycle Audio Band pass Filter	Active	Inactive	Inactive

4. PRELIMINARY CHECKS.

Preliminary checks should be made prior to placing the set in operation. These checks may be made by the operator providing he is familiar with the set.

a. A 200 to 600 ohm load, consisting of either a transformer-speaker, a resistor, or remote load must always be across the AUDIO output receptacle (J505), on the rear filter compartment, during operation. A head-telephone may be plugged into the PHONES jack (J404) on the front panel for monitoring.

b. Inspect the cables entering the rear compartment to ascertain that all are in place and the connectors screwed tight.

c. Unscrew one-quarter turn each of the four fasteners in the corners of the front panel, and pull the chassis partially out of the case by the handles. Check that the two crystals are in place (both are on top of the RF chassis). All tubes should have their shields or hold downs locked in place. Slide the chassis back in the case and tighten the fasteners.

5. OPERATION.

a. MODES OF OPERATION.—The AN/FRR-31 Radio Receiver is designed for single channel, crystal controlled, local or remote operation; it is not possible to change the operating frequency except by a change of the frequency determining crystal (Y101), and retuning the RF stages. Such changes in frequency require test equipment and should be performed only by qualified technicians.

(1) TYPES OF TRANSMISSION RECEIVABLE —The following types of transmission can be received by the AN/FRR-31:

Symbol	Type of Transmission
A1	Telegraphy, without the use of modulating audio frequencies (ON-OFF keying).
A2	Telegraphy by the keying of modulating audio frequency(s).
A3	Telephony (double-side-band full carrier).

(2) LOCAL AND REMOTE OPERATION.—This set may be operated from either the local or remote position. With the LOCAL-REMOTE switch on the LOCAL position all of the receiver controls are adjustable at the LOCAL position. When the set is switched to REMOTE operation, only the BFO, RF GAIN and the SQUELCH Test can be controlled from the REMOTE position. All other adjustments, channel frequency, RECEPTION mode, NOISE LIMITER operation, BROAD-SHARP SELECTIVITY and AF LEVEL, must be made initially at the receiver itself. Also in changing over from local to remote operation it may be necessary to readjust the audio level. In doing so, it will be necessary to remove the receiver from its case. The control is located on the Audio/Power Supply chassis. It will be impossible for the operator at the REMOTE position to control anything other than the BFO and RF GAIN in the A1 or A1 BROAD positions and the SQUELCH test in the A2-A3 position. The remote operator should be informed of any changes or alterations which are made after the initial set-up. After the initial set-up, it is necessary for the remote operator to know all the various settings made on the receiver. It is not necessary to have an additional operator stationed by the set during remote operation. The receiver can be monitored at all times through the head-telephone jack (J404). In addition to the steps stated above, those in paragraphs 1. thru 4. listed previously are also applicable.

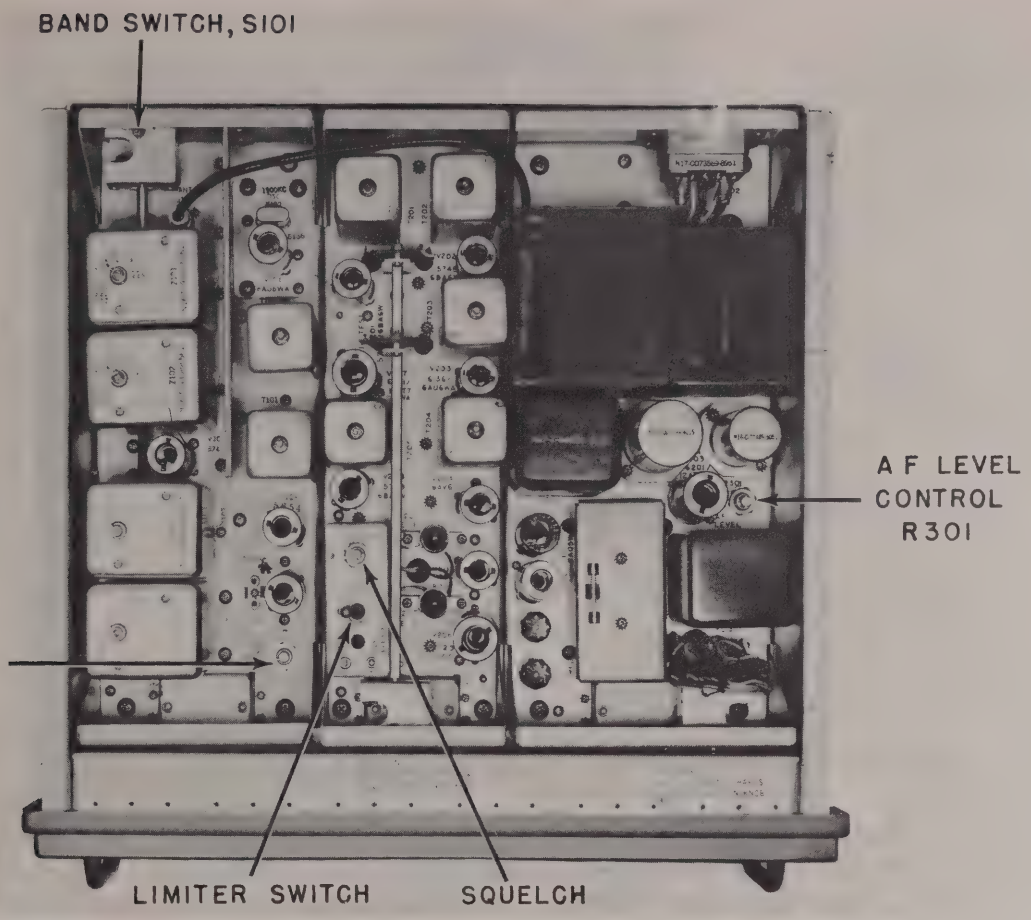


Figure 4-3. Top View of Receiver Set out of Case, Showing Chassis Controls

b. OPERATION.—The receiver RECEPTION switch is set for the type of transmission to be received and the LOCAL-REMOTE switch is set to LOCAL for adjustments.

(1) A2-A3 RECEPTION.

(a) A3 RECEPTION.—Set the SELECTIVITY switch to BROAD; the —6 db selectivity bandwidth is then 7-11 Kc. When receiving strong, interfering signals near the desired signal, it may be possible and desirable to utilize SHARP SELECTIVITY operation (about 2 Kc bandwidth) to reduce the unwanted signal while still retaining desired signal intelligibility.

(b) A2 RECEPTION.—Under most circumstances, BROAD SELECTIVITY should be used. If the modulating tones are under about 500 cycles, SHARP SELECTIVITY can be employed, especially under interference conditions.

(2) A1 BROAD RECEPTION.—The receiver audio frequency response for A1 BROAD reception, as for A2-A3, is at least from 300 to 3500 cycles. Therefore, with BROAD SELECTIVITY, continuous wave signal (A1) within approximately ± 3.5 Kc to ± 5.5 Kc of the receiver channel frequency can be received in this position, the beat tone being adjusted by the BFO control. The RF GAIN control is set for beat signal reception with the least background noise. With SHARP SELECTIVITY, signals within about ± 2 Kc of the channel frequency will be received. For minimum noise and interference, it is recommended that SHARP SELECTIVITY operation be used for A1 BROAD RECEPTION.

(3) A1 RECEPTION.—When the RECEPTION switch (S301) is in the A1 position, a 1000 cycle audio band pass filter is inserted in the audio amplifier following the audio limiter. This band pass filter gives the receiver additional selectivity for use on A1 reception. The audio band pass filter has a —6 db band pass of approximately 450 cycles width. The use of this filter will reduce interference from signals which are producing beat notes that are outside of this audio band pass. When the RECEPTION switch is in the A1 position, it will probably be most desirable to use the SELECTIVITY switch in the SHARP position, although the BROAD selectivity position can be used. The RF GAIN control is adjusted for optimum reception.

SECTION 5
OPERATOR'S MAINTENANCE

1. GENERAL.

Although maintenance of radio equipment is primarily the responsibility of technical personnel, it is nevertheless essential that the operator keep watch over his equipment during use, in order that minor defects may be discovered, and either corrected or reported before major trouble develops.

It is suggested that the routine operational check outlined below be made at the beginning of each watch, or when operation is resumed after more than 6 to 8 hours of idleness.

2. ROUTINE OPERATIONAL CHECK CHARTS.

The checks tabulated in table 5-1 should be made hourly during operation and at the beginning of each watch.

3. EMERGENCY MAINTENANCE.

a. GENERAL.—In addition to making the routine checks, previously outlined, the operator should be sufficiently familiar with his equipment to be able, in an emergency, to rectify minor damage or disarrangements which might develop during battle or other periods of emergency, when technical aid is not immediately available. Since, under such conditions, tube and fuse failures will be most likely and the most frequent cause of trouble, the information in the following paragraphs is provided to enable operating personnel to locate and replace these components, as required.

Notice To Operators

Operators shall not perform any of the following emergency procedures without proper authorization. Special care should be given to the clutches on the front panel controls. Extreme care must be taken so that they do not become damaged. It must be remembered that they must both be disengaged prior to removing any of the chassis from the receiver and reengaged when the chassis are replaced in the set.

b. FUSE INFORMATION.—Two 1-ampere, type 3AG, slow-blow glass cartridge fuses located on the top of the Audio/Power Supply sub-chassis as indicated in figure 5-1, are the only fuses used in Radio Receiver AN/FRR-31. These fuses protect the 105, 115, 125 volt, 50-60 cycle primary circuit. Access to the fuses is obtained by unscrewing the four fasteners in the corners of the front panel, and pulling the entire unit out of the case until the side latches prevent further movement. The fuses are removed by pushing down on the fuse holder head, then twisting it approximately one-quarter turn in a counterclockwise direction. The fuse holder head, with the fuse attached may now be lifted up. Condition of the fuse may be determined by observing through the glass casing whether the fuse link has been broken or melted. Always replace a bad fuse with one of exactly the same rating and type and, before replacing, check the cables and the set visually to make certain that no obvious faults exist. The description of the fuses is given in table 8-2 under F301.

TABLE 5-1. ROUTINE OPERATIONAL CHECK CHART

WHAT TO CHECK	HOW TO CHECK	REMARKS
Front Panel neon indicator lamp (I401)	Check visually to see that lamp glows when the power switch is in the ON position.	Failure of lamp to light indicates loss of B+ voltage, seldom due to failure of the lamp. Check fuses, AC input connections.
Receiver operation	Press the SQUELCH switch button on the front panel. A hiss noise in the speaker (or head-telephone) should result.	The receiver is normally adjusted so that it just quiets in the absence of a transmission signal.
External cables and connectors	Check connectors at the rear of the receiver for looseness or intermittent connection.	Loose connections may cause intermittent or noisy reception.
Operating controls	Check positions of controls for desired operation mode; LOCAL REMOTE Switch RECEPTION Switch BFO Control SELECTIVITY Switch RF GAIN	

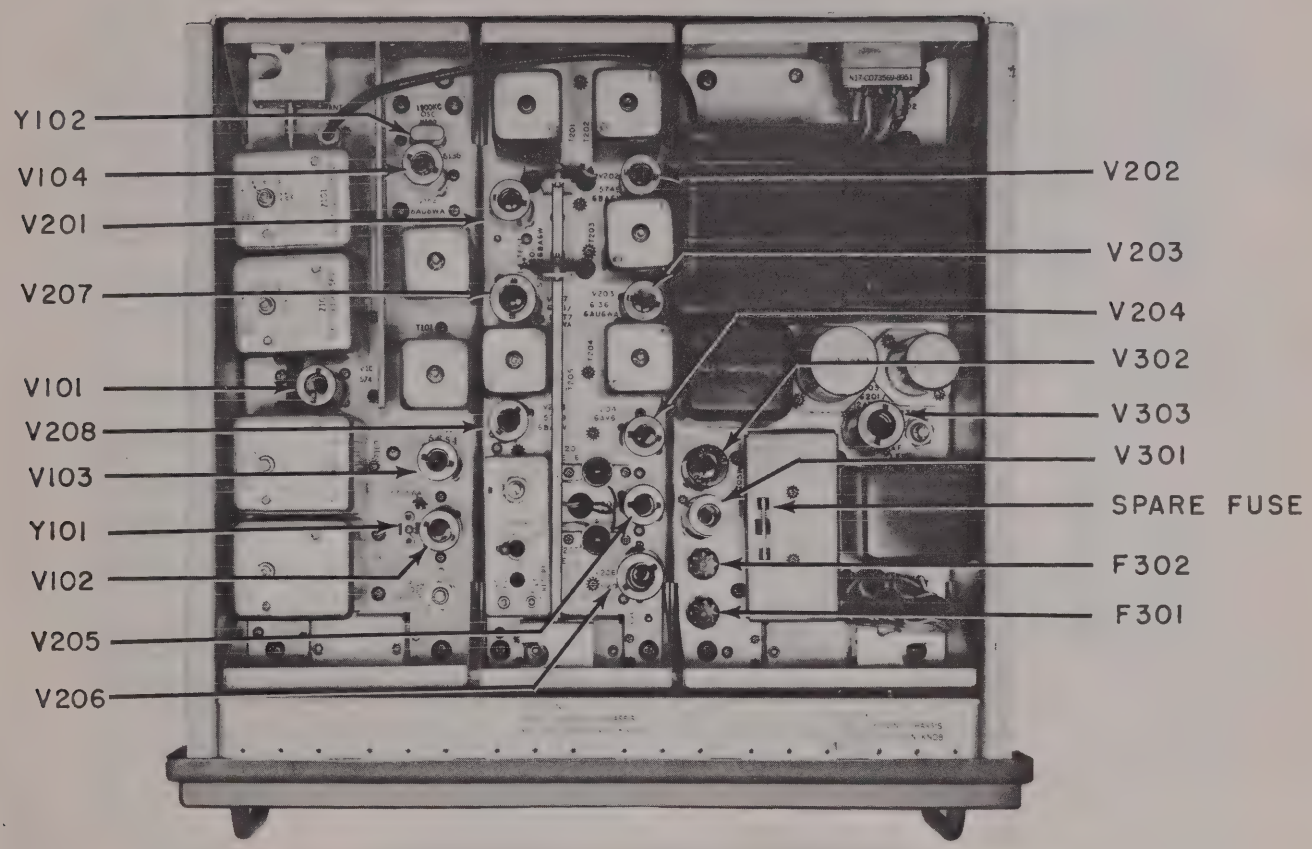


Figure 5-1. Top View of the Unit out of the Case Showing Crystals, Fuses and Tubes

A spare fuse is mounted in a clip next to the audio output transformer on the Audio/Power Supply subchassis, as indicated in figure 5-1. Additional spare fuses should be kept at hand for replacement use. If the fuse F301 and/or F302 blow following a replacement, check wiring and connections for obvious shorts. If no shorts are apparent, further servicing must be entrusted to qualified maintenance personnel.

CAUTION

Never replace a fuse with one of a higher rating unless continued operation of the receiver is more important than the probable damage to it. If a fuse burns out immediately after replacement, do not make a second replacement until the cause of the trouble has been corrected.

c. ELECTRON TUBE INFORMATION.—The full complement of electron tubes used in the AN/FRR-31 is given in table 1-4. These tubes are all located on the three chassis assembly units as indicated in figure 5-1.

To obtain access to the tubes, unscrew the four fasteners in the corners of the front panel and pull the receiver from the case as far as the mechanical stops will permit. This will permit access to most of the tubes. To check or replace the tubes at the extreme rear of the subchassis, the reciever must be entirely removed from the case. This can be done by pressing down on the two mechanical locks on each side of the case and pulling the receiver out. (See figure 5-2.)

If the receiver fails to operate, but the neon panel lamp remains lighted indicating the presence of B+ voltage, the cause may be attributable to tube failure. Since it will not be known which tube has failed, each tube in the receiver should be replaced with a tube (of the same type) known to be good until the defective one is located, in the following order: first those on the audio chassis, next those on the IF chassis and finally those on the RF chassis. Viewing these chassis from the front of the set, this order starts with the chassis on the right side and works toward the left.

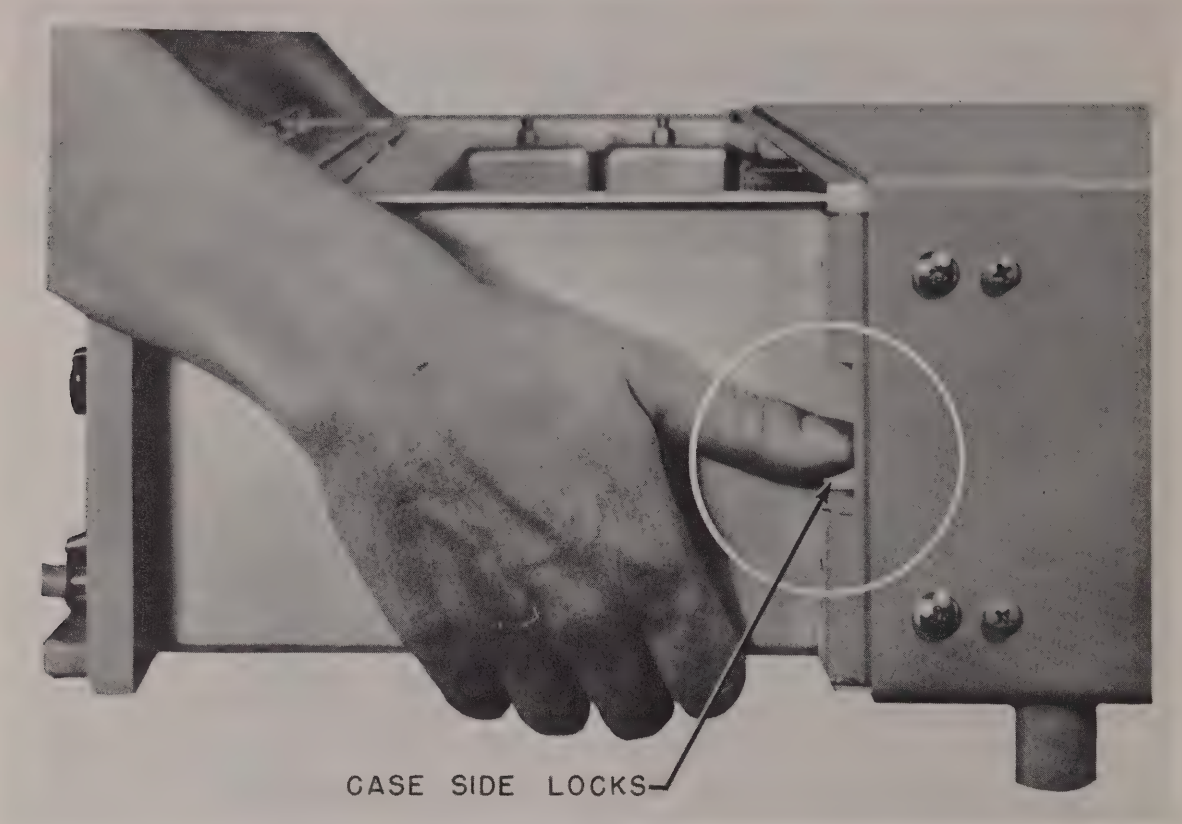


Figure 5-2. Operation of Case Side Locks

SECTION 6
PREVENTIVE MAINTENANCE

1. GENERAL.

While the AN/FRR-31 equipment has been designed and built to give as continuous and trouble free operation as possible, a certain amout of wear and deterioration must be expected in any apparatus of this nature. If detected and corrected at an early stage, trouble from these causes may be minimized, but if nothing is done until trouble actually occurs, a serious shut down may be necessary at a time when the use of the equipment is most needed.

Since wear and deterioration, though they represent potential trouble, are not always evident in themselves, it is essential to continued trouble-free operation that certain vital points be inspected periodically, and the necessary replacements and adjustments be made when discovered. Such systematic inspection and adjustment will insure consistent operation, and will increase the efficiency and life of the equipment.

A practical working schedule is outlined below. However, it may be found desirable to modify this schedule as experience dictates, since the exact intervals at which certain maintenance procedures must be performed will be determined by such factors as the operating schedule of the station or ship and prevailing atmospheric conditions.

2. ROUTINE MAINTENANCE CHECK CHARTS.

TABLE 6-1. ROUTINE MAINTENANCE CHECK CHART

WHAT TO CHECK	HOW TO CHECK	PROCEDURE
HOURLY OR EVERY WATCH		
	See routine check chart table	
DAILY AND WEEKLY		
	None required	
MONTHLY		
Receiver sensitivity and receiver gain	Check as outlined in SECTION 7, Corrective Maintenance.	If sensitivity or receiver gain is low, receiver may require tube replacement and/or alignment as outlined in SECTION 7.
Cables and connectors	Detach cables and examine insulation for possible damage. Examine all connectors for loose, bent or dirty contacts; also damaged threads.	If dirt or grease on contacts; clean with dry cleaning solvent 140F SNSN G51-S-4718-10, observing necessary precautions in use.
Front panel and sub-panel controls	Check for looseness of switch and mounting nuts, missing or loose knobs.	Tighten loose screws and nuts; replace missing knobs.
QUARTERLY		
Electron tubes	Check all electron tubes in a transconductance type tube tester. Replace any tube having a transconductance of less than 75% of normal.	When replacing tubes, realignment of the circuit affected may be necessary.
ANNUALLY		
Receiver chassis and cabinet	Inspect receiver chassis, top and bottom for loose parts, assembly and chassis assembly screws. Inspect for dirt or dust on tube sockets, connectors, variable capacitors, and terminal strips. Inspect cabinet for loose mounting screws. Check for damage due to overheating.	A small paint brush or non-linting cloth may be used to remove dirt from tube sockets and easily accessible points. Use compressed air to clean out the more inaccessible points or areas.

SAFETY NOTICES

THE ATTENTION OF MAINTENANCE PERSONNEL IS INVITED TO THE REQUIREMENTS OF CHAPTER 67 OF THE "BUREAU OF SHIPS MANUAL", OF THE LATEST ISSUE. PERSONNEL ARE ALSO REQUESTED TO READ THE SAFETY INSTRUCTIONS INCLUDED IN THE FRONT MATTER FOR THIS BOOK.

3. OVERALL INSPECTION.

An overall inspection of the equipment is recommended as a precautionary measure immediately before putting into service, and thereafter at intervals of three or four months, the exact intervals depending upon service conditions and upon whether or not any faults have developed.

Such an inspection involves a complete examination of electrical wiring and mechanical details, and of electrical and mechanical operation. Also any cleaning necessary to remove accumulated dirt.

Suggested routines for periodic electrical and mechanical inspection are given in the routine maintenance check charts. Check especially the clutches on the front panel to insure that they have not been damaged in any way and that they are free from all accumulated dirt deposits. It must be kept in mind that they must be disengaged prior to removing any of the chassis from the receiver and reengaged when the chassis are replaced in the set.

4. LUBRICATION.

No part of Radio Receiving Set AN/FRR-31 will require lubrication at any time as a preventive measure against damage to the equiment. However, a little Navy type 16-L-2 grade II, medium, ball bearing lubricant applied to the bottom guide rails inside the case will facilitate removal of the chassis from the cabinet and its reinsertion.

5. RE-TROPICALIZATION.

In manufacture, the AN/FRR-31 equipments are not tropicalized as complete assemblies, but instead, use is made of materials and parts which are inherently moisture and fungus resistant. Since the repair parts provided are identical with the parts used in the equipment, the overall resistance of the equipment to moisture and fungus should be unaffected. The terminal boards in the AN/FRR-31 are made of silicon glass laminate.

NOTES

FAILURE REPORTS

"Report each failure of the equipment, whether caused by a defective part, wear, improper operation, or an external cause. Use ELECTRONIC FAILURE REPORT form DD 787. Each pad of the forms includes full instructions for filling out the forms and forwarding them to the Bureau of Ships. However, the importance of providing complete information cannot be emphasized too much. Be sure that you include the model designation and serial number of the equipment (from the equipment nameplate), the type number of the major unit (from the major unit nameplate), and the type number and reference designation of the particular defective part (from the instruction book). Describe the cause of the failure completely, continuing on the back of the form if necessary. Do not substitute brevity for clarity. And remember — there are two sides to the failure report.

"YOUR SIDE"

Every FAILURE REPORT is a boost for you:

1. It shows that you are doing your job.
2. It helps make your job easier.
3. It insures available replacements.
4. It gives you a chance to pass your knowledge to every man on the team.

"BUREAU SIDE"

The Bureau of Ships uses the information to:

1. Evaluate present equipment.
2. Improve future equipment.
3. Order replacements for stock.
4. Prepare field changes.
5. Publish maintenance data.

Always keep a supply of failure report forms on board. You can get them from the nearest District Publications and Printing Office."

SECTION 7
CORRECTIVE MAINTENANCE

1. INTRODUCTION.

Corrective maintenance covers that phase of the care of the equipment which deals with the location and correction of trouble which has already occurred, and which is beyond the province of the operator to attempt to correct. For this work, it is assumed that technical personnel with radio training are available.

SAFETY NOTICE

THE ATTENTION OF MAINTENANCE PERSONNEL IS INVITED TO THE REQUIREMENTS OF CHAPTER 67 OF THE "BUREAU OF SHIPS MANUAL", OF THE LATEST ISSUE. PERSONNEL ARE ALSO REQUESTED TO READ THE SAFETY INSTRUCTIONS INCLUDED IN THE FRONT MATTER FOR THIS BOOK.

2. TROUBLE SHOOTING.

a. GENERAL.—When properly installed, any irregularities which occur in the performance of the equipment will be attributable either to misadjustment of one or more of the controls, or to the failure of some part. In most cases, it will be possible to localize a particular fault from the general nature of the trouble encountered. Faulty or abnormal action of a particular control will often indicate the particular section of the receiver, and the specific portion of the circuit in which the trouble lies.

b. TROUBLE SHOOTING CHART.—In tracing faults, an orderly and systematic procedure should be followed. The trouble shooting chart (see table 7-12) gives the symptoms of troubles commonly encountered.

c. VOLTAGE AND RESISTANCE MEASUREMENTS.—The values of voltage and resistance from each tube socket terminal to ground and/or other significant points are shown in figure 7-16. All tube sockets, terminal boards, and connectors are readily available on the bottom of the receiver chassis and rear compartment excepting XV101 and the chassis connectors. A cover over the XV101 socket must be removed to permit access to the terminals. In order to remove the RF bottom shield cover, it is first required to remove the RF chassis from the frame assembly by loosening the four corner captive screws. The cover may then be removed by inserting the fingers underneath it and pulling upward. Pressure type clips, on either side, hold the cover in place.

Special check points are available on the top of the IF and RF chassis assembles. These test points permit voltage checks of the frequency determining oscillator, OSC TEST; detector, DET TEST; and AGC circuit, AGC TEST (as outlined in table 7-6 to 7-11).

Conditions under which all of the above measurements were made are outlined in the individual tables, as specified above. All measurements should be made with an AN/USM-34, ME-25/U series, or a Navy Model OBQ series, or equivalent electronic multimeter. Resistance measurements are made with the power connector disconnected and the receiver chassis out of its case.

Values of voltage and resistance as measured in the equipment should be within ±20 per cent of those given in the figures and tables.

3. ELECTRON TUBE INFORMATION.

a. TUBE DATA.—The full complement of electron tubes used in Radio Receiver AN/FRR-31 is given in table 1-4. These tubes are all located on either the RF, IF, or Audio/Power Supply chassis assemblies of the receiver. Their locations on these individual chassis are shown in figure 5-1.

Voltage and resistance measurements between each pin of each tube and ground or other significant points, are given in figure 7-16 and table 7-13.

The rated operating characteristics of each type of tube employed are listed in table 7-14. Physical dimensions and characteristics curves are not given as this information is readily available in standard commercial catalogs.

b. TUBE CHECKING.—Access to all tubes is obtained by unscrewing the four Simmons fasteners on the front panel (one-quarter turn counterclockwise), depressing the two side lock latches (see figure 5-2) and pulling the chassis completely out of its case.

If the receiver fails to operate, but the panel neon lamp remains lighted indicating the presence of B+ voltage, the cause may be attributable to tube failure. Since it will not be known which tube has failed, each tube in the receiver should be replaced with a tube known to be good (and of the same type) in the following order until the defective one is located: first those on the Audio/Power Supply chassis, next those on the IF chassis, and finally those on the RF chassis.

NOTE

All tubes of a given type supplied with the equipment shall be consumed prior to employment of tubes from general stock.

TABLE 7-1. TEST EQUIPMENT REQUIRED

Equipment	Range Required	Model
Signal Generator	120 Kc and 2020 Kc	Navy Model AN/URM-25
Signal Generator	8 to 32 Mc	Navy Model AN/URM-25
Vacuum Tube Voltmeter	0 to 300 volts DC 0 to 250 volts AC	Navy Model AN/USM-34, OBQ or ME-25/U
Audio Output Meter	0.06 Mw to 2 Watts	Model AN/URM-38, ME-49/U or 22195
Heterodyne Frequency Meter	120 Kc	Navy Model AN/USM-29

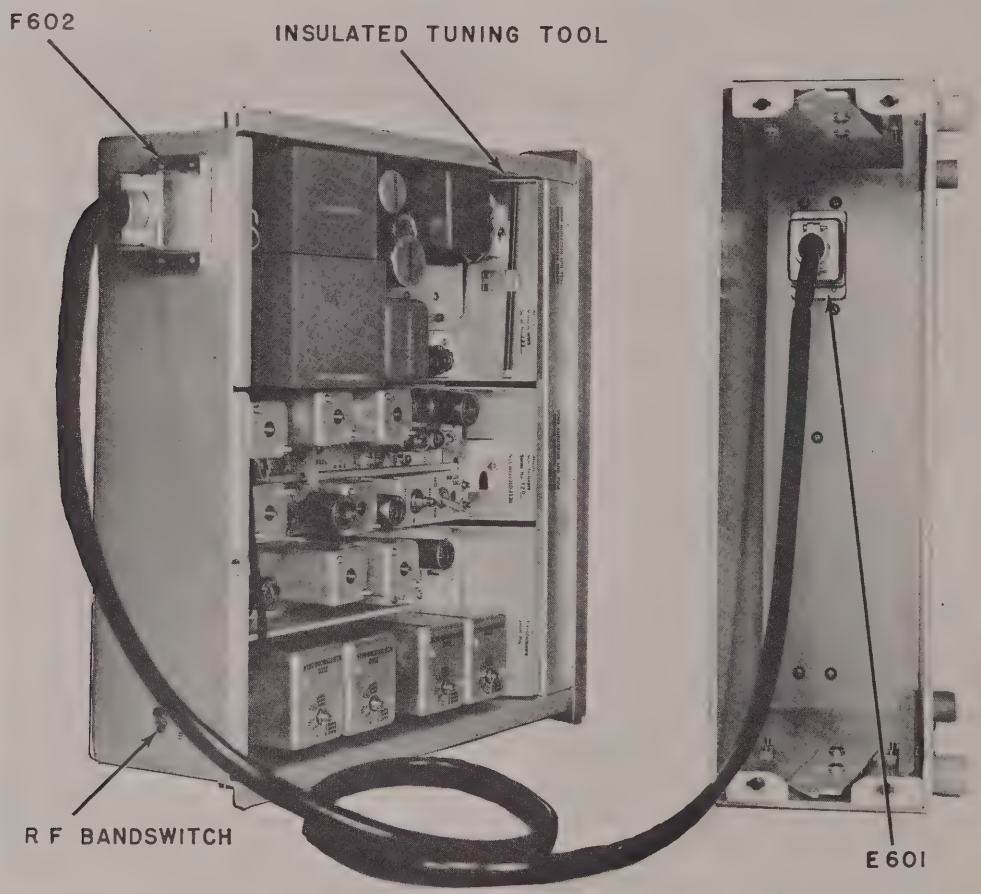


Figure 7-1. Receiver and Case, Connected by W601 Cable

4. ALIGNMENT PROCEDURES.

a. EQUIPMENT REQUIRED.—The test equipment, or equivalent, as listed in table 7-1, should be available for proper alignment of the RF and IF sections, and for making audio checks.

b. PREPARATION OF THE RECEIVER FOR ALIGNMENT.

(1) Remove the receiver from its case by turning the four Simmons fasteners on the front panel one-quarter turn counterclockwise; pull chassis out as far as the case locks will permit; release these two side locks by depressing the latches on the side of the case and pull chassis out of the case. (See Fig. 5-2.)

(2) Check the voltage of the available AC power source; move switchable link on terminal board TB 301 (see figure 2-17) to the tap most nearly corresponding with the measured line voltage.

(3) Connect test cable W601 between the receiver chassis receptacle (J302), and the rear panel case receptacle J504. (See Fig. 7-1.)

(4) Connect an audio load of 200-600 ohms impedance to the AUDIO receptacle J505 (pins A and B), located on the rear panel of the cabinet. This load can be a speaker, an audio output meter, or a resistance. (See Fig. 7-2.)

(5) Throw the NOISE LIMITER switch (S202), located on the IF chassis, to OFF. (See Fig. 4-3.)

(6) Turn the SQUELCH threshold control (R217) located on the IF chassis, open (fully counterclockwise). (See Figs. 4-3, 2-9.)

(7) Plug a 600 ohm audio output meter into the head-telephone jack (J404) located on the front panel. (See Figs. 4-1, 7-2.)

(8) Turn the PHONES level control (R401), located on the front panel, to maximum (fully clockwise). (See Figs. 4-1, 7-2.)

(9) Turn the RECEPTION switch (S301), located on the right side of the front panel, to the A2-A3 position. (See Fig. 7-2.)

(10) Turn the LOCAL-REMOTE switch (S403), located at the center of the front panel, to the LOCAL position. (See Fig. 7-2.)

(11) Turn the SELECTIVITY switch (S201), located at the center of the front panel, to the SHARP position. (See Fig. 7-2.)

(12) Adjust the BFO control (R406), located at the left hand side of the front panel, to 50% rotation. (See Fig. 7-3.)

(13) Turn the RF GAIN control (R405), located at the center of the front panel, to maximum clockwise position. (See Fig. 7-2.)

(14) Turn the AF LEVEL control (R301), located on the Audio/Power Supply chassis, to approximately 70% of maximum clockwise rotation. (See Fig. 2-16.)

(15) Connect the line from the AC power source to the AC POWER receptacle (J502), located on the rear panel. Throw the POWER switch (S401), located on the front panel, to ON. (See Fig. 7-2.)

c. RECEIVER SECTION ALIGNMENT ORDER.—The receiver sections are aligned in the following order:

(1) Align 120 Kc IF stages. (See Fig. 7-2, Table 7-2.)

(2) Tune BFO to proper frequency. (See Fig. 7-2, Table 7-3.)

(3) Align 2020 Kc IF transformer. (See Fig. 7-3, Table 7-4.)

(4) Align RF stages. (See Fig. 7-6, Table 7-5.)

Steps 1, 2 and 3 are performed at the factory and rarely require further adjustment.

Step 4 must be performed each time the receiver is changed to a new channel frequency.

NOTE

All IF transformers are aligned with a conventional insulated aligning screwdriver. The transformers require tuning from both the top and underside of the chassis. A nonmatallic screwdriver should be used if the regular tuning tool is not available. The tuning tool supplied with the receiver is mounted inside the Audio/Power Supply chassis.

WARNING

WHEN THE RECEIVER HAS BEEN PREPARED FOR ALIGNMENT AND THE POWER SWITCH IS OFF, DANGEROUS VOLTAGES ARE STILL PRESENT AT THE FOLLOWING POINTS:

AC POWER connector J502, J504 and filter networks connections if the rear filter compartment cover plate is removed (See Fig. 2-20.)

Chassis connector J302 (See Fig. 2-16.)

Power fuses F301 and F302 (See Fig. 5-1.)

POWER switch S401 terminals (See Fig. 2-3.)

Terminal pins numbers 14 and 16 of connectors J301 and J403 (See Figs. 1-5, 2-17.)

d. 120 Kc IF AMPLIFIER ALIGNMENT.

(1) Set up the receiver chassis and test equipment, as indicated in Figure 7-2.

(2) Prepare the 120 Kc signal generator for use by adjusting it to exactly 120 Kc with a Frequency Meter. Proceed with the alignment as outlined by steps 1 to 4 in Table 7-2.

e. BFO ALIGNMENT (120 Kc).

(1) Turn the RECEPTION switch (S301) to A1-BROAD reception.

(2) See that the RF GAIN control (R405) is at the maximum clockwise position and the BFO control (R406) is exactly at 50% rotation (mid-range) (See SECTION 4, para. 3.a.(1) and 3.a.(4).).

(3) Turn the AF LEVEL control (R301), located on the Audio/Power Supply chassis assembly, to a maximum clockwise position.

(4) The same exact 120 Kc frequency and SET UP as used in steps 3 and 4 of table 7-2 for 120 Kc IF amplifier alignment should be used for the BFO alignment as indicated in table 7-3.

TABLE 7-2. 120 KC IF AMPLIFIER ALIGNMENT

STEP	TEST SIGNAL	TEST SIGNAL INJECTION POINT	METER	ALIGN	REMARKS
1	120 Kc set accurately; 30% 400 cycle modulation, with 0.01 μf isolation capacitor in high lead.	Pin #1 (control grid) of V203 second 120 Kc IF amplifier.	600 ohm audio output meter, connected to the headphone jack. (J-404), or AUDIO output connector (J505)	T204 (both slugs)	For sharpest peaks and greatest accuracy in alignment, keep the output of the signal generator low to avoid overloading the audio stages and below the AGC threshold of operation. This practice should be followed in aligning all stages.
2	Same as above	Pin #1 (control grid) of V202 first 120 Kc IF amplifier.	Same as above	T203 (both slugs)	Same as above
3	Same as above	Pin #1 (control grid) of V201 second mixer or IF TEST point.	Same as above	T202 and T201 (both slugs)	It may be necessary to increase the signal a substantial amount in order to force enough signal through T201 and T202 to obtain a tuning indication on the output meter. Steps 1 through 3 constitute a rough tuning procedure.
4	Same as above	Same as above	Same as above	T204 (both slugs)	(a) Screw out top slug until limit is felt (do not force) (b) Peak bottom slug (c) Peak top slug Note: at all times, keep signal at lowest possible level, which should be below the AGC threshold, but consistent with obtaining a usable tuning indication on the audio output meter.

TABLE 7-3. BFO ALIGNMENT

STEP	TEST SIGNAL	TEST SIGNAL INJECTION POINT	METER	ALIGN	REMARKS
1	120 Kc. (set accurately); unmodulated.	Pin #1 (control grid) of V201, second mixer.	Use 600 ohm headphones, plugged into headphone jack (J404), or a 200-600 ohm speaker connected to the high level audio output connector J505, located on the rear filter assembly of the cabinet.	T205 (slug in top)	Adjust this slug until zero beat (or near zero beat) is obtained against the incoming signal generator freq. of exactly 120 Kc. Make certain that the front panel BFO control R406 is very close to 50% of its maximum rotation.

f. 1900 KC OSCILLATOR.—This oscillator has no means of adjustment, and should function normally by inserting hte 1900 Kc crystal (Y102). (See Fig. 7-5.). When the crystal is inserted, the DC grid voltage as measured on pin #1 of XV104 should be checked. It should be approximately 6.3 volts DC. No further checks are necessary unless the circuit is not functioning properly.

g. 2020 Kc IF ALIGNMENT.

(1) Turn the RECEPTION switch (S301) located on the front panel to A2-A3 reception.

(2) Turn the AF LEVEL control (R301) located on the Audio/Power Supply chassis to 70% rotation.

(3) See that the 1900 Kc crystal (Y102) is inserted in its socket and is oscillating properly. This can be checked by measuring the DC voltage present from Pin #1 to ground, across R212 of V104 (1900 Kc oscillator). For proper oscillation this voltage should be approximately 6.3 volts DC.

(4) Make certain that the SELECTIVITY switch is in the SHARP position.

(5) Refer to Figure 7-3 for proper signal generator, and audio output meter connection.

(6) Tune 2020 Kc IF transformers accordingly to table 7-4.

b. CRYSTAL Y101, FREQUENCY COMPUTATION.—The AN/FRR-31 receiver has been designed to operate with a channel determining oscillator crystal of type CR-18/U. The use of any other crystal that will fit in the crystal socket XY101 of the channel determining oscillator V102, which has been ground to have characteristics very similar to the CR-18/U crystal, will most probably perform correctly. The oscillator must generate an injection frequency which is 2020 Kc higher than the desired channel frequency in the lower half of Band I (8-12 Mc) and 2020 Kc lower throughout the remainder of the receiver range. In bands II and III, the second harmonic of the crystal is used. For proper operation of the receiver in the SHARP selectivity position, the crystal oscillator frequency must be within approximately 100 cycles, so that incoming signals on the desired frequency will fall close to the center of the bandpass. For additional details of determination of crystal frequency, refer to SECTION 2, para. 2.a.(3).

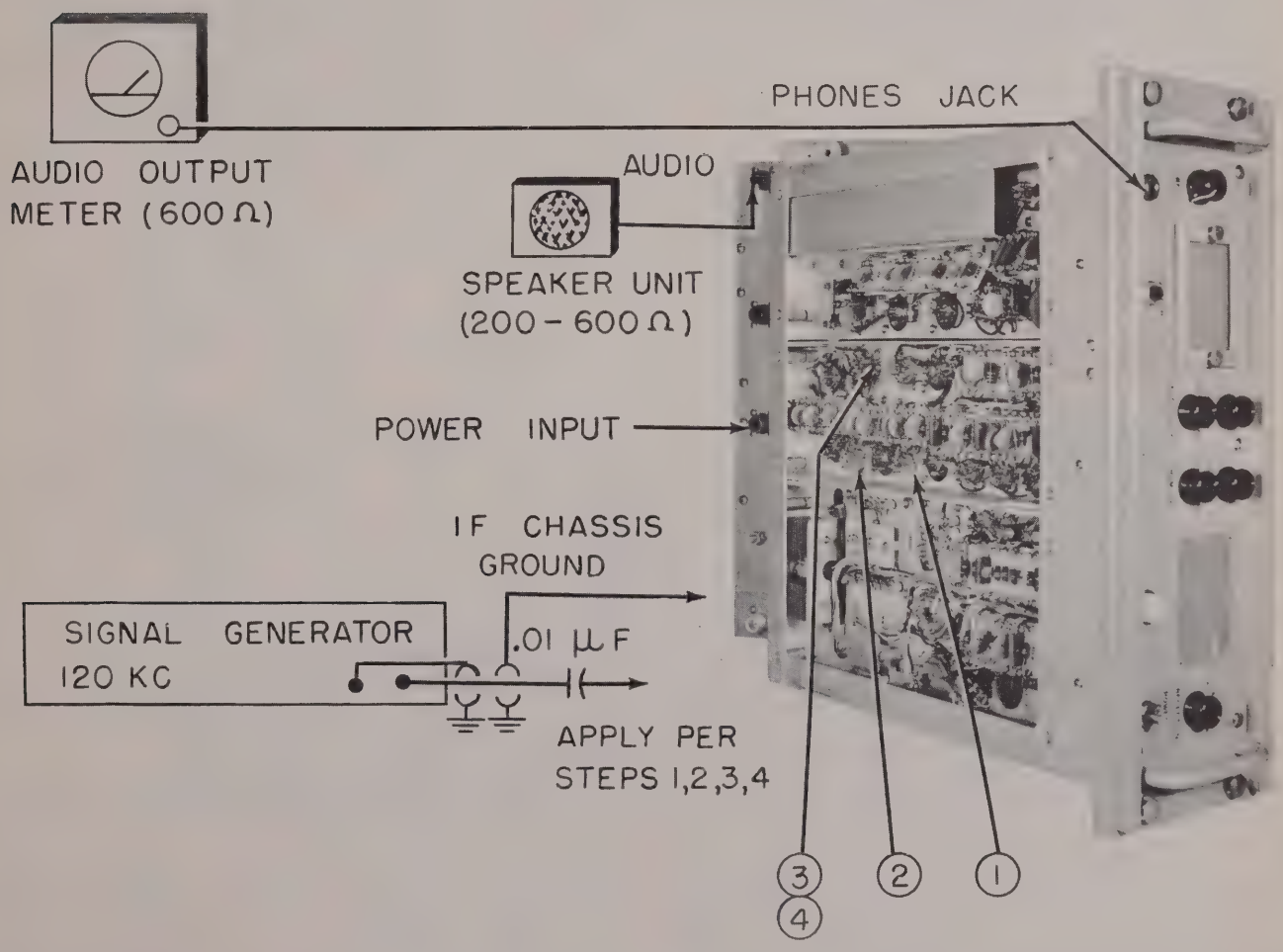


Figure 7-2. 120 Kc IF Amplifier Alignment Set-up

TABLE 7-4. 2020 KC IF ALIGNMENT

STEP	TEST SIGNAL	TEST SIGNAL INJECTION POINT	METER	ALIGN	REMARKS
1	Approximately 2020 Kc 30% 400 cycles modulation.	Pin #4 of T102 (located on the bottom side of the RF chassis assembly)	Use 600 ohm audio output meter plugged into the head-telephone jack on the front panel	——	The signal generator frequency should be altered (rocked) until the 30% 400 cycles modulation signal is found and then peaked
2	2020 Kc 30% 400 cycles modulation; put exactly on frequency by peaking for maximum audio output as indicated in the text.	Pin #1 of T101 (located on the under side of the RF chassis assembly)	Same as above	T102 (both slugs)	Keep signal generator output low; so that the signal is below the level necessary to operate the AGC, and below any overload point of the audio amplifier stages
3	Same as above	Pin # (control grid) of the first mixer V103	Same as above	T101 (both slugs)	Same as above
4	Same as above	Same as above	Same as above	Both T101 and T102 individually by the following method	(a) Screw out the top slug until the audio output has been reduced approximately 10 db, or until limit is felt (do not force). If the audio output level is too low to be read properly on the audio output meter provided, turn the AF level control (R301) to a somewhat higher value. (b) Peak bottom slug. (c) Peak top slug. (The peaking of both top and bottom slugs should be done carefully in order to provide the 2020 Kc IF stages with a band width that is wide enough to receive the maximum band width which could be expected when the SELECTIVITY switch (S201) is in the BROAD position.

i. CHANNEL DETERMINING OSCILLATOR ADJUSTMENT.

(1) Insert channel determining crystal Y101 in socket XY101.

(2) Correct the receiver and vacuum tube voltmeter as indicated in figure 7-3 and proceed with the adjustment as indicated in figure 7-5.

(3) OSCILLATOR ACTIVITY control (R114) is capable of varying the crystal activity over a range varying from approximately —0.4 volts to approximately —2 volts. In order to compensate for the variation in crystal activity between various crystals, this control is adjusted for the desired amount of crystal activity as measured at the OSCILLATOR TEST point C114. Below, listed in figure 7-5, are the approximate oscillator test point voltages to be expected for best overall operation of the receiver throughout its range.

(4) The OSCILLATOR ACTIVITY control (R-114) should be adjusted for approximately 50% rotation until after the RF stages have been properly aligned.

(5) After the RF stages have been properly aligned, as indicated in table 7-5, the OSCILLATOR ACTIVITY control (R114) may be adjusted for the proper amount of crystal activity by setting the control in accordance with figure 7-5. Some variation of these values may be expected due to receiver component tolerances. This should be done when the RECEPTION switch has been set for A2-A3 operation in the absence of an incoming signal.

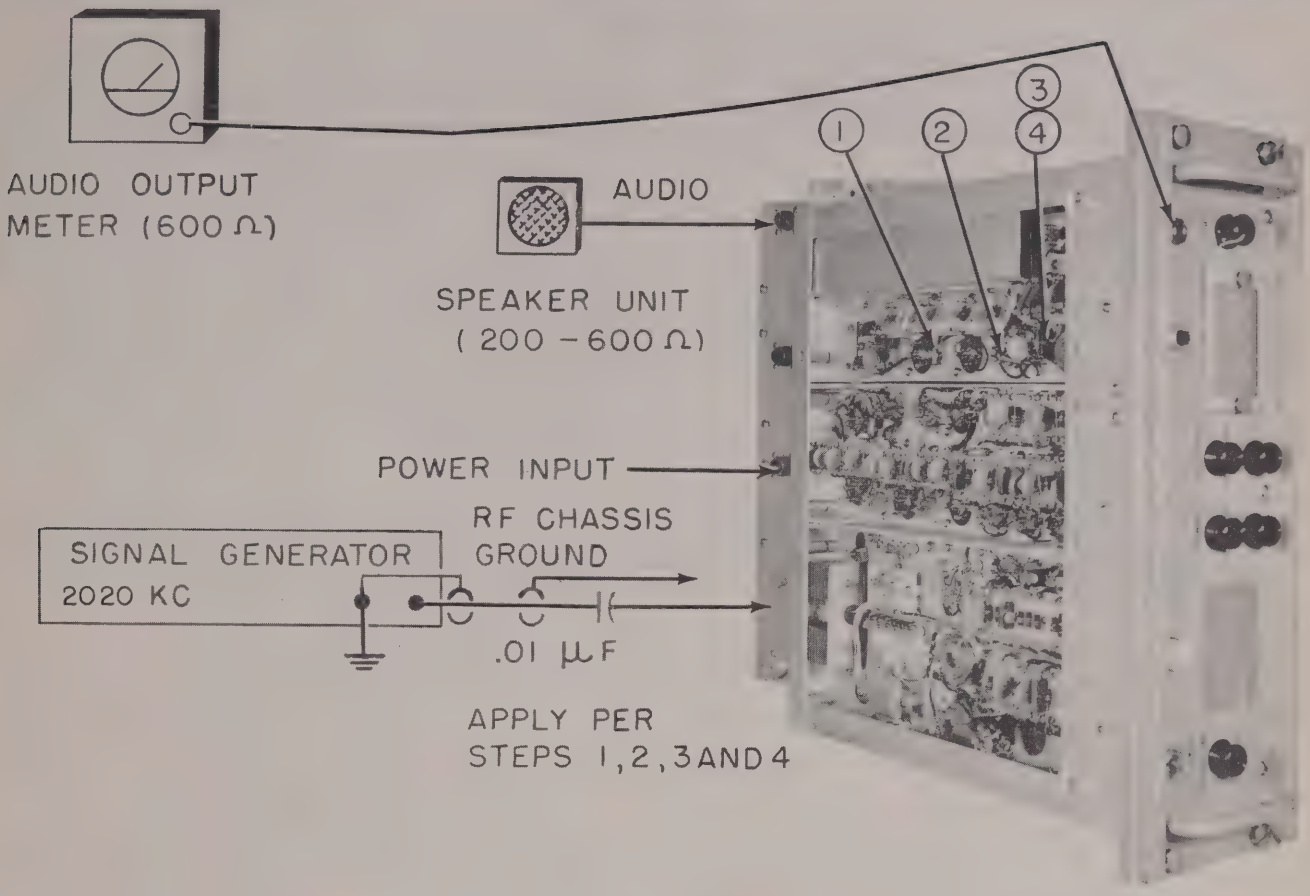


Figure 7-3. 455 Kc IF Amplifier Alignment Set-up

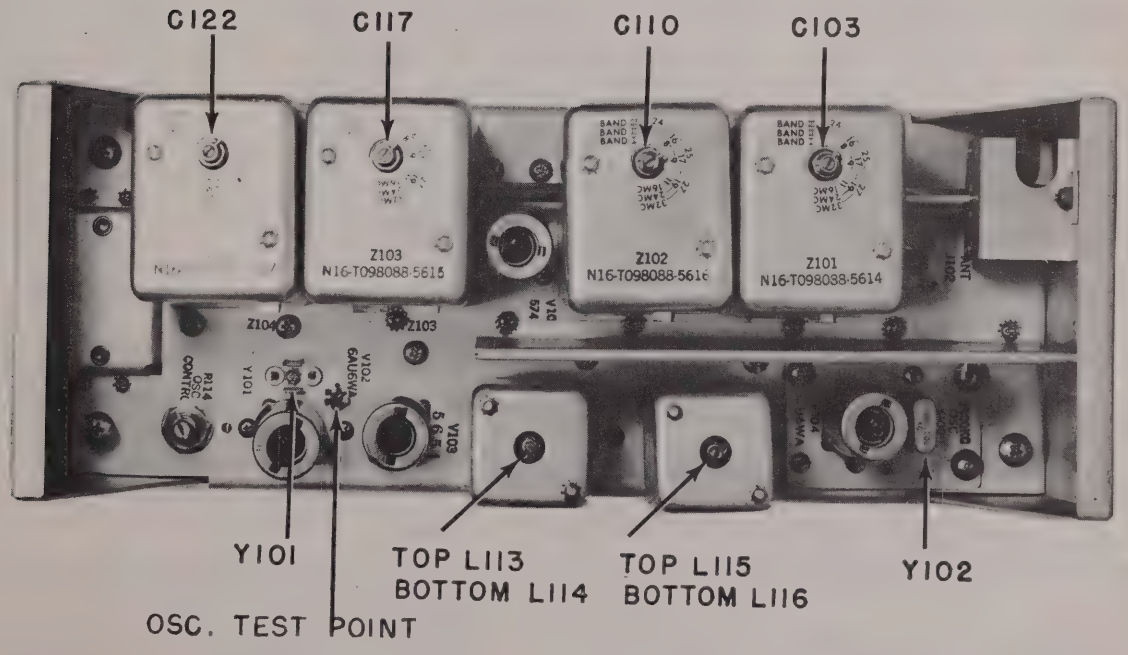


Figure 7-4. Top View of the RF Chassis Showing Coils, Condensers, Crystals and Test Points

TABLE 7-5. RF AMPLIFIER ALIGNMENT

STEP	TEST SIGNAL	TEST SIGNAL INJECTION POINT	METER	ALIGN	REMARKS
1	None	———	———	Z101, Z102, Z103, Z104	Set to the desired frequency by the calibrations provided on the top of the transformer shield can.
2	Approximate channel frequency; 30%, 400 cps modulation.	Antenna receptacle on RF chassis or 72 OHM ANTenna receptacle J501 on the rear panel	Use 600 ohm audio meter plugged into head-telephone jack on front panel, or connected to the high level AUDIO output receptacle J505 on the rear compartment.	Signal generator to the channel frequency	Roughly set the signal generator to the desired frequency. Use a strong signal and vary (rock) the generator frequency to obtain a maximum output, as indicated on the audio output meter. Reduce signal to the minimum usuable (as indicated on the audio output meter) for tuning.
3	Adjusted signal from Step 2	Same as above	Same as above	Z101, Z102, Z103, Z104	Careful alignment is not necessary, as this is a rough alignment of the RF coils.
4	Same as above	Same as above	Same as above	Z101, Z102, Z103, Z104 by the following methods.	Detune Z101 in either direction, so that the audio output will decrease roughly 10 db (this is done to reduce any pulling effect Z101 might have on Z102). Peak Z102 carefully for maximum output as indicated on the audio output meter. Peak Z101 for maximum audio output. Z102 should not again be readjusted unless the entire procedure is repeated. Detune Z103 either higher or lower in frequency so that the audio output is decreased approximately 10 db. Peak Z104 for maximum audio output, and then peak Z103. Z104 should not again be peaked unless the entire procedure is repeated.

j. RF STAGE ALIGNMENT.

(1) Leave all receiver controls as previously adjusted, during the IF amplifier alignment. Make certain the RF band switch is on the proper band, i.e. I, II or III.

(2) Each time the channel frequency is changed, the RF stages must be re-aligned, as outlined below.

(3) Connect the receiver, RF frequency signal generator, and audio output meter as indicated in figure 7-6 and proceed with the alignment as outlined in table 7-5.

(4) The 8-32 Mc signal generator output should be 30% modulated at 400 cycles, and can be connected directly to the RF chassis receptacle (J102) or to the rear filter assembly ANTENNA input connection (J501).

(5) Make certain the SELECTIVITY switch is in the SHARP position.

(6) The RF alignment procedure given in table 7-5, namely of detuning, peaking and repeaking, is necessary to assure that the receiver will have a symmetrical bandpass, proper spurious, image, selectivity and cross-modulation characteristics, particularly at the lower frequencies of its 8-32 Mc range.

(7) It will be noticed that a dip in the audio output is possible when Z104 is tuned to the injection frequency (crystal frequency). This is of little concern but it is best to avoid this point when detuning as outlined in step 4 of table 7-5, RF Amplifier Alignment.

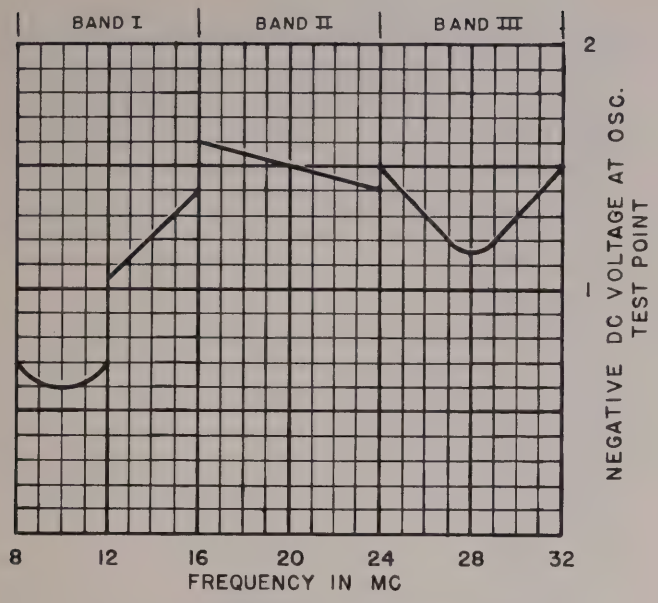


Figure 7-5. Channel Determining Oscillator, Frequency vs Voltage

(8) Before the completion of the alignment, the OSCILLATOR SELECTIVITY control (R114) must be adjusted for the proper amount of crystal activity by setting the control in accordance with figure 7-5. Some variation of these values may be expected due to receiver component tolerances. Voltages are measured at th OSCILLATOR TEST point (C114), with a vacuum tube voltmeter having an input impedance of at least 11 megohms. With the SELECTIVITY switch in the BROAD position, the AGC threshold of operation will be between signal input of 5-8 microvolts, if the proper amount of crystal activity is obtained. Under these circumstances the A2-A3 sensitivity for a signal-to-noise ratio of 10 db will be approximately 4 to 5 microvolts. The A1 RECEPTION switch position will afford an A1 sensitivity of less than 5 microvolts when the SELECTIVITY switch (S201) is in the SHARP position.

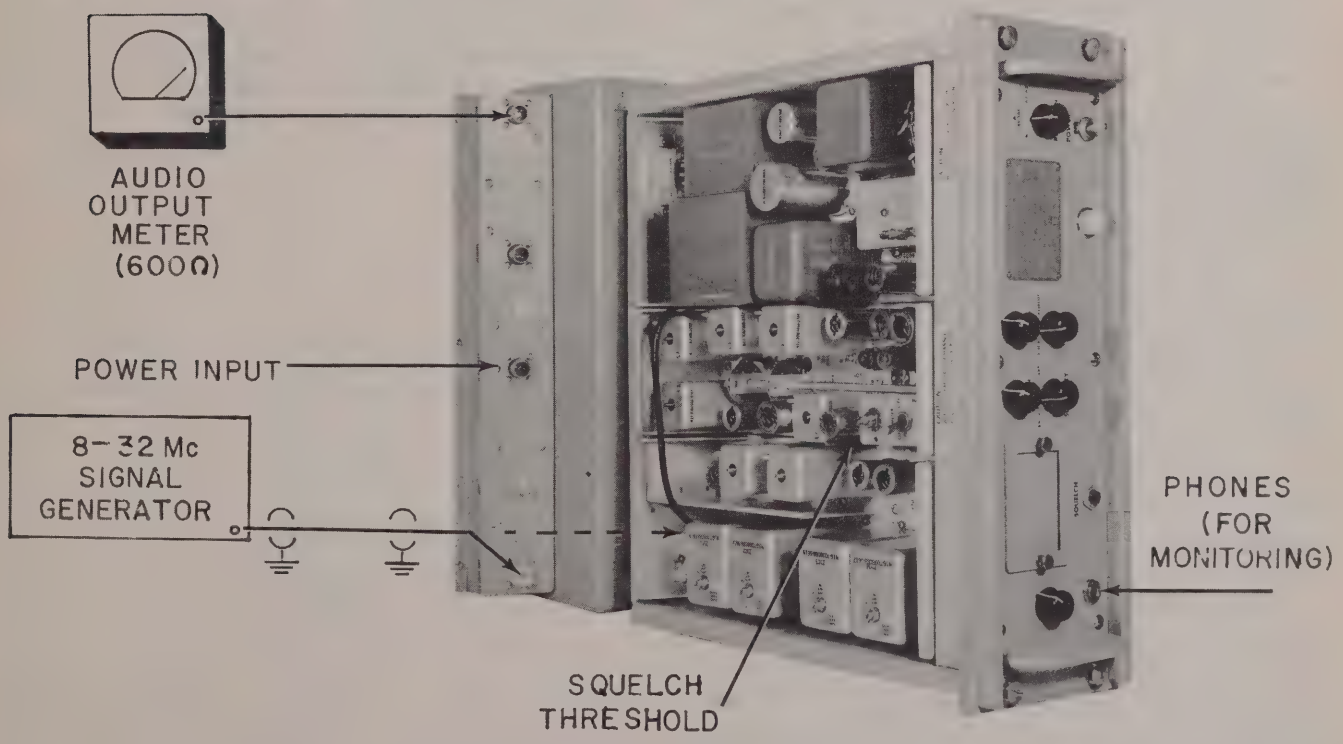


Figure 7-6. Set-up for RF Amplifier Alignment and Squelch Threshold Adjustment

k. CONTROLS ADJUSTMENT.—After completion of the alignment, the chassis controls must be adjusted before the receiver is placed in the cabinet. This procedure is described in SECTION 3, para. 4.

l. SQUELCH THRESHOLD ADJUSTMENT.—The SQUELCH control (R217), located on the IF chassis assembly, is operative only when the RECEPTION switch (S301) is in the A2-A3 position. The receiver may be adjusted to any point of squelch opening desired, from a completely unsquelched condtion to a point where a signal of over 100 microvolts is required to open the squelch. In SECTION 3, para. 4. a. (14), a method of setting this control for the most sensitive point is described. Should circumstances require that the squelch open at some definite signal strength, a signal generator with its output accurately calibrated in microvolts is required, and the following procedure should be followed. (See Fig. 7-6.)

(1) The receiver chassis must be withdrawn from the case and connected to it by the W601 test cable. (See Fig. 7-1.)

(2) Connect the signal generator (72 ohm output impedance) to the 72 OHM ANTenna input on the rear panel, or the RF connector (J102) on the RF chassis. Adjust the signal generator output to the desired signal strength. Turn the receiver ON, and the NOISE LIMITER switch ON and allow the set to warm up.

(3) Rotate the SQUELCH threshold control (R-217) from a fully clockwise setting towards a fully counterclockwise position, until the point is reached where the desired signal level causes the squelch to open. Leave the control at this point. Remove the signal generator and restore the receiver to its normal operating condition.

m. SELECTIVITY ADJUSTMENT.

(1) For A3 Reception.—It is highly recommended that the BROAD selectivity position of the SELECTIVITY switch (S201) be utilized. The —6 db bandwidth in the BROAD position is 7 to 11 Kc. When receiving strong interfering signals near the desired frequency, it may be possible to utilize the relatively sharp selectivity of the SHARP position of the SELECTIVITY switch. The selectivity on the SHARP position has a bandwidth of approximately 2 Kc.

(2) A2 Reception.—A2 reception, as used with this receiver, is referred to as a steady carrier, modulated with a keyed tone. For all practical purposes, this type of reception, as far as the circuits provided, is identical to A3 reception. Under most circumstances the BROAD selectivity position of the SELECTIVITY switch should be used, although when modulating tones of 500 cycles or less are used, suitable operation can be obtained by using the SHARP selectivity position.

(3) A1 BROAD Reception.—When the RECEPTION switch (S301) is in the A1 BROAD position, the 1000 cycle audio band pass filter has been removed from the audio circuits, and the overall audio response extends from below 300 cycles to over 3500 cycles. When the SELECTIVITY switch (S201) is in the BROAD position, it is possible to receive CW signals (A1) within a total bandwidth of at least 7 Kc. It is recommended for A1 BROAD reception that the SHARP selectivity position be used.

(4) A1 Reception.—When the RECEPTION switch (S301) is in the A1 position, a 1000 cycle audio band pass filter is inserted in the audio amplifier following the audio limiter. This band pass filter gives the receiver additional selectivity for use on A1 reception. The audio band pass filter has a —6 db band pass of approximately 450 cycles width. The use of this filter will reduce interference from signals which are producing beat notes that are outside of this audio band pass. When the RECEPTION switch is in the A1 position, it will probably be most desirable to use the SELECTIVITY switch in the SHARP position, although the BROAD selectivity position can be used. The RF GAIN control is adjusted for optimum reception.

5. SUPPLEMENTARY TEST DATA.

The following tables 7-6, 7-7, 7-8, 7-9, 7-10, 7-11, while not required for the alignment, provide an accurate and reliable means of maintaining the receiver at peak performance, and offer a check against the correctness of receiver alignment. To make these tests, addi-

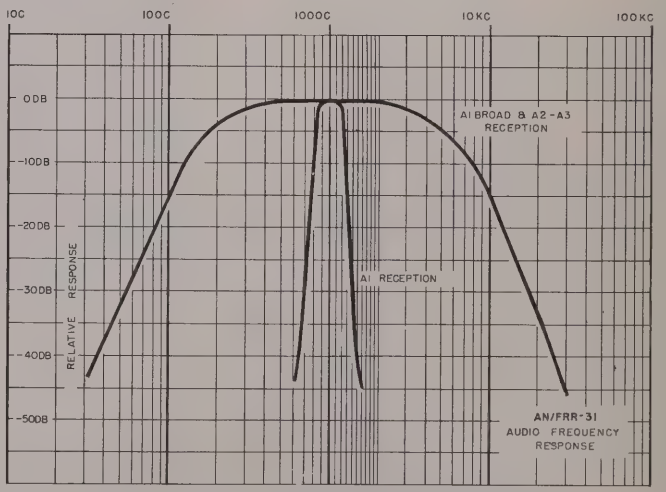


Figure 7-7. Audio Frequency Response

tional equipment is necessary such as a signal generator with an accurately calibrated output in microvolts, an audio oscillator with an output calibrated in millivolts (or means of measuring the output), a 600 ohm impedance audio output meter with a range of at least 0.06 milliwatts to 2 watts. Control settings and conditions of test are included in the following tables.

a. AUDIO TEST DATA.

(1) Connect a 600 ohm audio output meter across pins A and B of AUDIO receptacle (J505), located on the rear panel. The test set-up is shown in figure 7-8. Proceed with the test as outlined in table 7-6. The overall audio response is additionally indicated by figure 7-7.

TABLE 7-6. AUDIO TEST DATA

Steps	Test Point	Test Input Voltages RMS 1000 cycles (approx.)		Output Meter Reading (600 ohm load)
		A1 and A1 BROAD	A2-A3	
1	Detector Return	1.2 V	2.0 V	1 watt
2	V205, Pin 2	0.65 V	1.0 V	1 watt
3	V206, Pin 2	0.225 V	0.38 V	1 watt
4	V303, Pin 8	0.75 V	—	1 watt
5	V303, Pin 3	0.66 V	—	1 watt
6	V301, Pin 1	0.65 V	0.65 V	1 watt
7	V302, Pin 1	3.3 V	3.3 V	1 watt

Conditions of Test: AF LEVEL control at maximum (clockwise); NOISE LIMITER, ON; SQUELCH circuit disabled; Automatic on A1 reception, and by turning SQUELCH control counterclockwise or by pressing SQUELCH test switch for A2-A3 reception; Signal injection through 0.1 microfarad, or larger capacitor

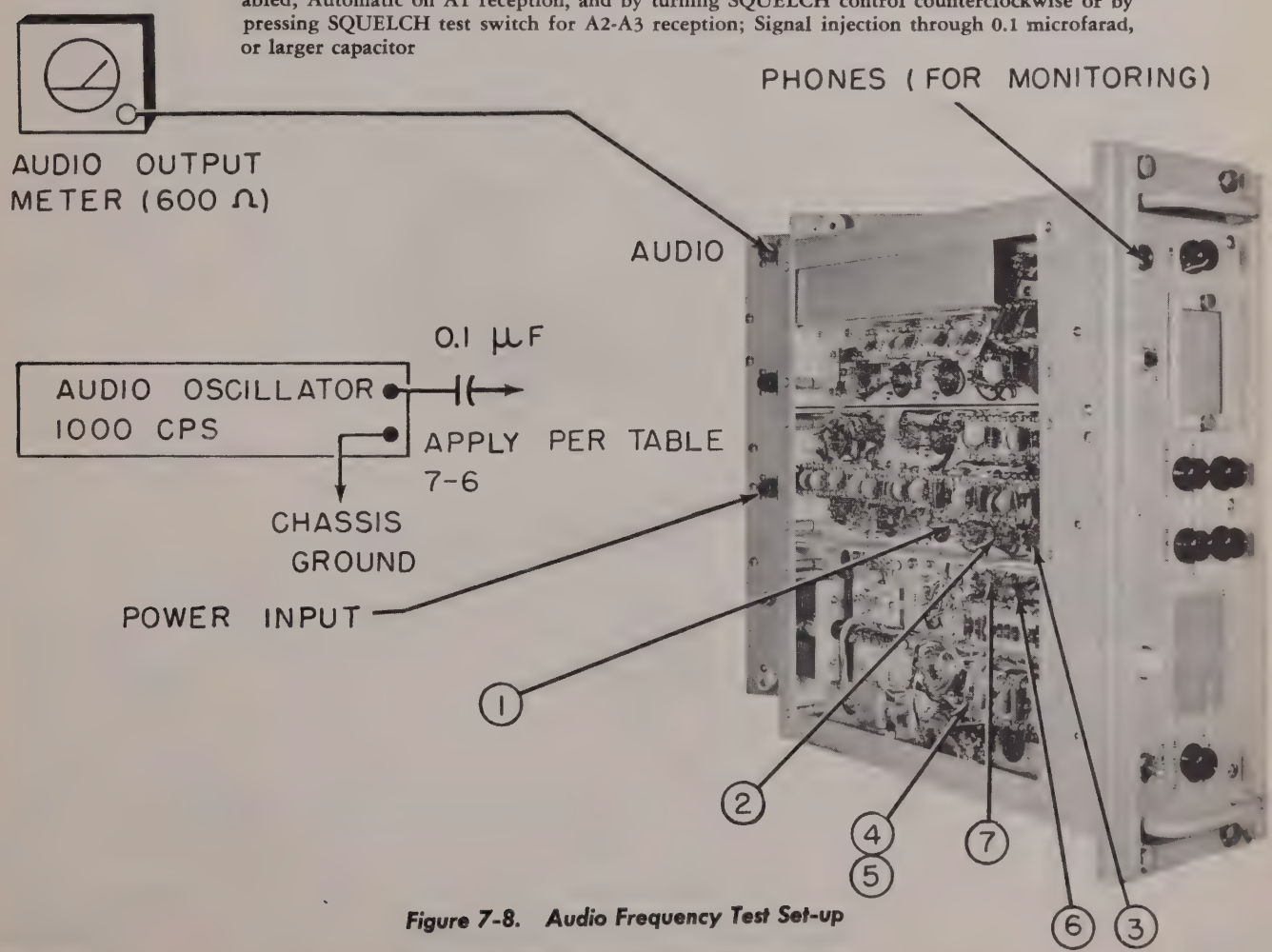


Figure 7-8. Audio Frequency Test Set-up

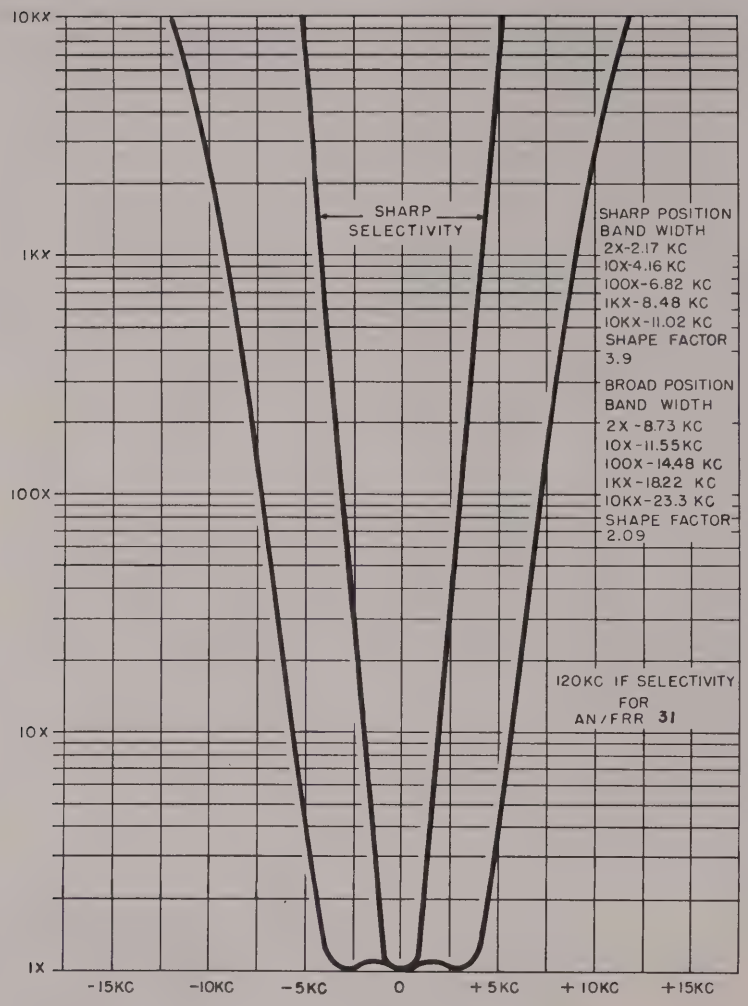


Figure 7-9. IF Selectivity Curves

TABLE 7-7. 120 KC INTERMEDIATE FREQUENCY TEST DATA

Test Conditions	A1 and A1 BROAD	A2-A3 Reception
SELECTIVITY switch	BROAD	BROAD
RF GAIN control	Max. (clockwise)	—
BFO control		—
SQUELCH control	—	Min. (counter-clockwise)
AF LEVEL control	Max. (clockwise)	Max. (clockwise)
NOISE LIMITER switch	ON	ON

TABLE 7-7. (Continued) 120 KC INTERMEDIATE FREQUENCY TEST DATA

Test Conditions	A1 and A1 BROAD	A2-A3 Reception
Input Signal Frequency	120 Kc	120 Kc
Input Signal Modulation	None	30%, 1000 cps
Input Signal: Applied through a 0.01 microfarad capacitor.		
Output Voltages:		
DET TEST POINT (Measured to DET RETURN TEST point)	—7 V	—7 V
Input Points:		
V203, Pin 1	44,000 microvolts	44,000 microvolts
V202, Pin 1	690 microvolts	480 microvolts
V201, Pin 1	50 microvolts	34 microvolts

b. 120 Kc INTERMEDIATE FREQUENCY DATA.

(1) Connect the 600 ohm audio output meter across A and B of the AUDIO output receptacle (J505) located on the rear panel. The test set-up is shown in figure 7-10. Proceed with the tests as outlined in table 7-7. The over all audio response is additionally indicated by figure 7-7.

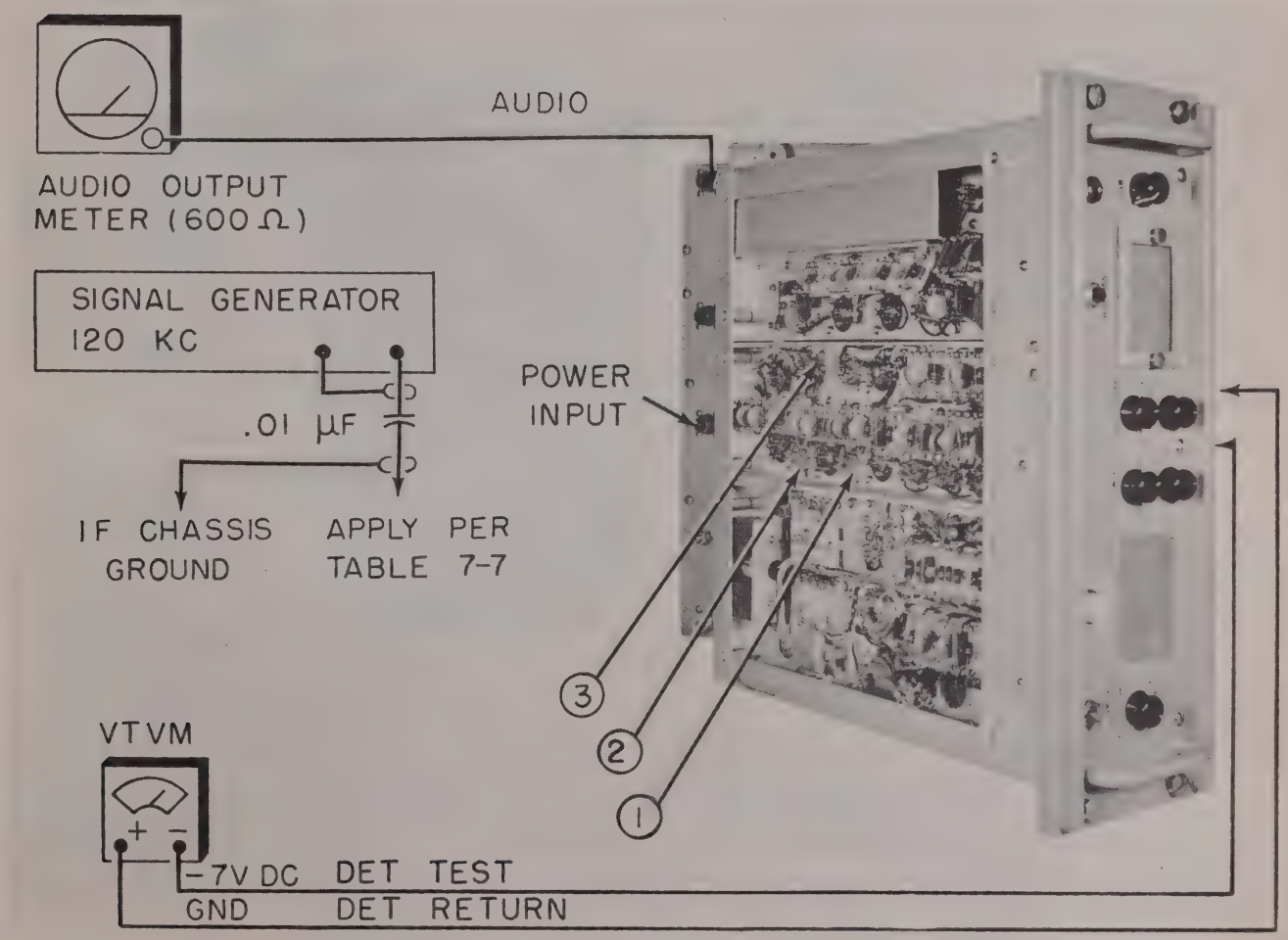


Figure 7-10. 120 Kc IF Test Set-up

TABLE 7-8. 2020 KC INTERMEDIATE FREQUENCY DATA

Test Point	Test Input Voltage (approx.)	Detector Meter Reading
V103, Pin 1	10 microvolts	—7 V DC

Conditions of Test: Signal generator, accurately calibrated in microvolts; AF LEVEL control at maximum (clockwise); NOISE LIMITER switch ON; SELECTIVITY switch in the BROAD position; RECEPTION switch in A2-A3 position.

Input Signal: 2020 Kc, 30% modulated at 1000 cycles through a 0.01 microfarad capacitor.

c. 2020 Kc INTERMEDIATE FREQUENCY DATA.

(1) Connect the 600 ohm audio output meter across pins A and B of the AUDIO receptacle (J505), located on the rear filter compartment. The test setup is shown in figure 7-11. Proceed with the test, as outlined in table 7-8.

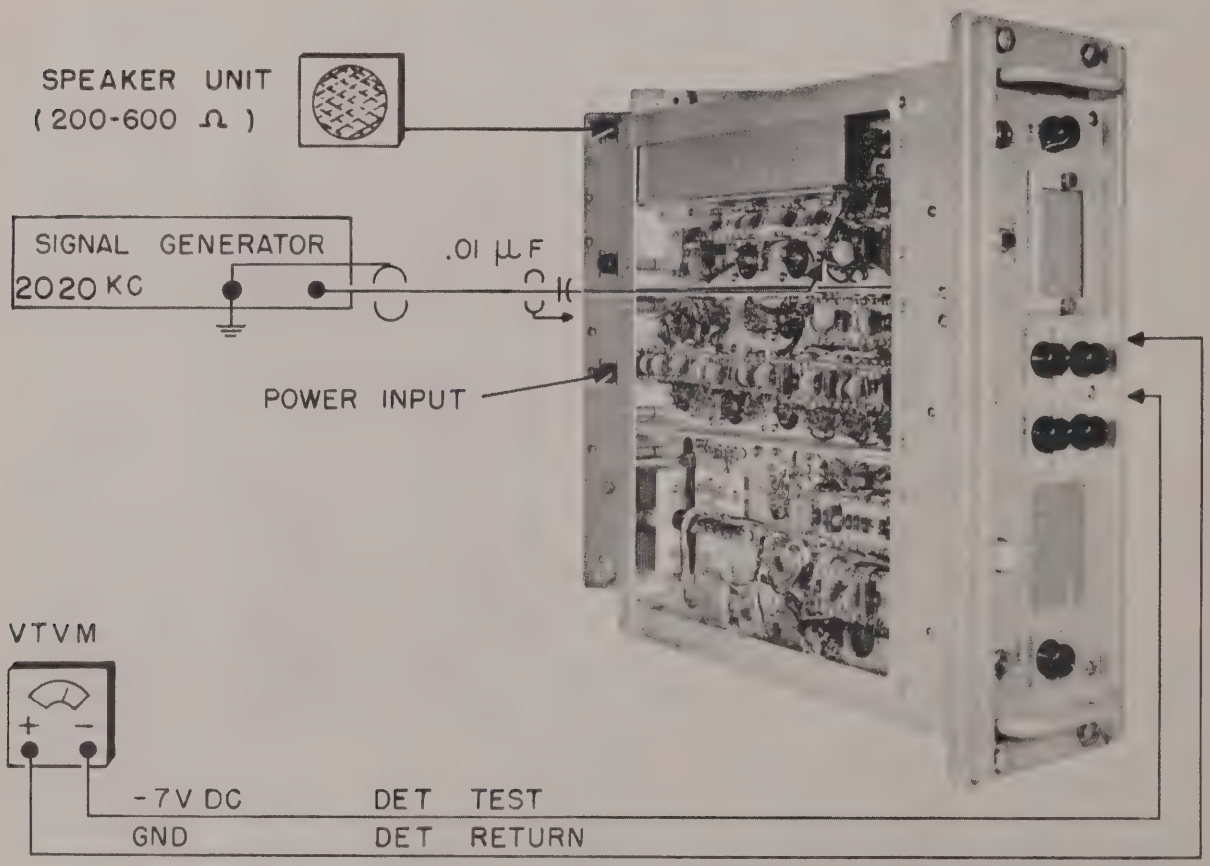


Figure 7-11. 2020 Kc IF Test Set-up

TABLE 7-9. OVERALL RECEIVER SENSITIVITY FOR A2-A3 RECEPTION

STEP	TEST SIGNAL	TEST SIGNAL INPUT INJECTION POINT	OUTPUT METER	PROCEDURE
1	8-32 Mc, 30% 1000 cycle modulation	Antenna receptacle on RF chassis or 72 OHM ANTenna receptacle on rear panel.	600 ohm audio output meter	With modulation ON, observe and record the db indication on the output meter.
2	8-32 Mc unmodulated	Same as above	Same as above	When the modulation is switched OFF, the db reading will decrease. The amount of decrease desired is exactly 10 db and is obtained by increasing or decreasing the signal generator RF output. Adjust the RF signal, alternately cutting the modulation ON and OFF until an exact 10 db difference is obtained. The amount of RF signal required to obtain this difference should be less than 8 microvolts.
3	Various frequencies throughout the receiver tuning range	Same as above	Same as above	Check this signal plus noise-to-noise ratio at various points throughout the receiver tuning range.

Conditions of Test: AF LEVEL control at approximately 50% rotation; NOISE LIMITER switch OFF; SELECTIVITY switch in the BROAD position. The receiver tuned according to instructions furnished in this section.

Input Signal: As indicated in steps 1 through 3.

Signal Generator: The signal generator must be accurately calibrated in microvolts. The output must present a 72 ohm impedance to the receiver. The signal generator microvolt or output calibration must refer to a source voltage rather than the actual RF voltage appearing at the output terminals of the signal generator when loaded with a 72 ohm external load such as the receiver input. If the generator's output impedance is less than 72 ohms, a series resistor must be added to bring it up to 72 ohms and the actual receiver input source voltage calculated.

TABLE 7-10. OVERALL RECEIVER SENSITIVITY FOR A1 RECEPTION

STEP	TEST SIGNAL	TEST SIGNAL INPUT INJECTION POINT	OUTPUT METER	PROCEDURE
1	8-32 Mc Kc unmodulated	Antenna receptacle on the chassis or 72 OHM ANTenna receptacle on the rear panel.	600 ohm audio output meter	With the RECEPTION switch in the A1 BROAD position and the SELECTIVITY switch in the SHARP position, the BFO control should be adjusted for approximately 1000 cycles audio tone as obtained by a pair of 600 ohm headphones plugged into head-telephone jack (J404) or by a speaker load connected to the high level AUDIO receptacle (J505). With the carrier ON, the db reading on the output meter should be recorded.
2	Same as above	Same as above	Same as above	When the carrier is switched OFF, the db reading will decrease. The amount of decrease desired is exactly 20 db, and is obtained by increasing or decreasing the signal generator RF output.

TABLE 7-10. (Continued) OVERALL RECEIVER SENSITIVITY FOR A1 RECEPTION

STEP	TEST SIGNAL	TEST SIGNAL INPUT INJECTION POINT	OUTPUT METER	PROCEDURE
3	Same as above (modulated or unmodulated)	Same as above	Same as above	Adjust the RF signal generator output, alternately switching it ON and OFF until an exact 20 db difference is obtained. The amount of RF signal required to obtain this difference should fall within the range of 1 to 5 microvolts.

Conditions of Test: AF LEVEL control at maximum clockwise rotation; NOISE LIMITER switch OFF, RF GAIN control maximum, and SELECTIVITY switch in SHARP position.

Input Signal: As indicated in steps 1 through 3.

Signal Generator: The signal generator must be calibrated accurately in microvolts. The output must present a 72 ohm impedance to the receiver. If the generator's output impedance is less than 50 ohms, a series resistor must be added to bring it up to 72 ohms and the actual receiver input voltage calculated. The signal generator microvolt calibration must refer to a source voltage rather than the actual measured voltage present across the output terminals when a 72 ohm external load is connected.

d. OVERALL RECEIVER SENSITIVITY.

(1) A2-A3 Reception.—This characteristic is the amount of RF signal required to obtain a 10 to 1 signal plus noise-to-noise ratio when modulation of an incoming signal is switched ON and then OFF. For A1 reception, sensitivity is the amount of unmodulated RF signal required to obtain a 20 to 1 signal plus noise-to-noise ratio when the signal is switched ON and then OFF. In the AN/FRR-31, the overall sensitivity for A2 or A3 reception is between 2 and 8 microvolts for a 10 to 1 signal plus noise-to-noise ratio, throughout the 8-32 Mc range of the receiver. For A1 and A1 BROAD reception, the sensitivity is between 1 and 5 microvolts for a 20 to 1 signal plus noise-to-noise ratio.

(2) Connect a 600 ohm audio output meter across pins A and B of the AUDIO receptacle (J505) located on the rear panel. (See figure 7-12.) Proceed with the test, as outlined in tables 7-9, 7-10.

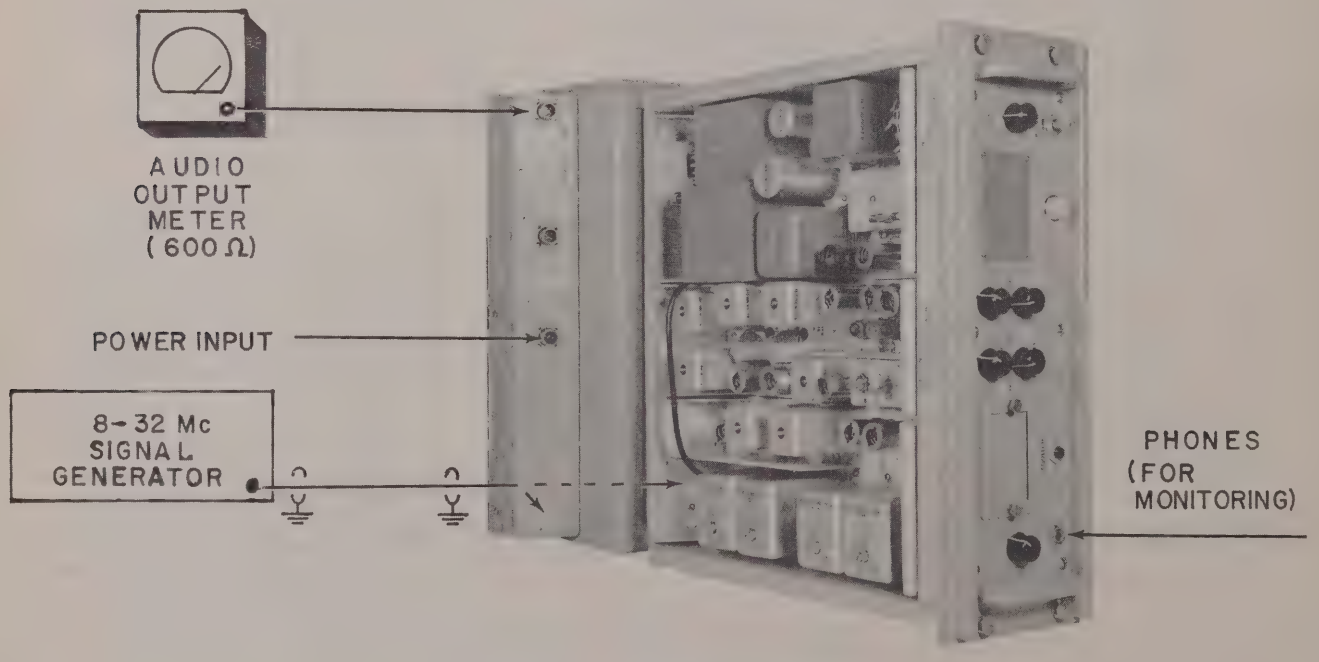


Figure 7-12. Sensitivity Test Set-up

TABLE 7-11. TYPICAL RF INPUT READINGS FOR SIGNAL STRENGTH MEASUREMENTS

INPUT (MICROVOLTS)	DETECTOR OUTPUT - VOLTS	AGC OUTPUT - VOLTS
1	— 6.6	— 0.0
3	—14.5	— 0.45
5	—14.5	— 1.2
10	—14.5	— 1.6
30	—15.	— 2.9
100	—15.5	— 4.6
1,000	—16.5	— 9.6
10,000	—17.5	—14.7
100,000	—19.2	—22.7

Conditions of Test: Signal generator (72 ohm impedance) connected to the 72 OHM ANTenna input on rear panel, or the RF receptacle J102 on the RF chassis assembly; when checking Detector output, connect the vacuum tube voltmeter to the "DET" Metering and "DET RETURN" points, both on the IF chassis assembly; when checking the AGC voltage, connect the vacuum tube voltmeter to the "AGC" Metering point and the ground pin; AF LEVEL Control, full counter-clockwise; RECEPTION switch, A2-A3; SELECTIVITY switch, BROAD; NOISE LIMITER, ON.

Input Signal: 24 Mc, 30 per cent modulated at 1000 cycles.

e. SIGNAL STRENGTH MEASUREMENTS. (See table 7-11.)—Typical input readings for signal strength measurements provide additional means of checking the receiver sensitivity. Bear in mind that these readings given in this table are only approximations, and may vary from one receiver to another due to variations in resistors, voltages, signal frequencies, etc. A signal generator with an output accurately calibrated in microvolts, and a vacuum voltmeter are required to make these checks. (See Figure 7-13.)

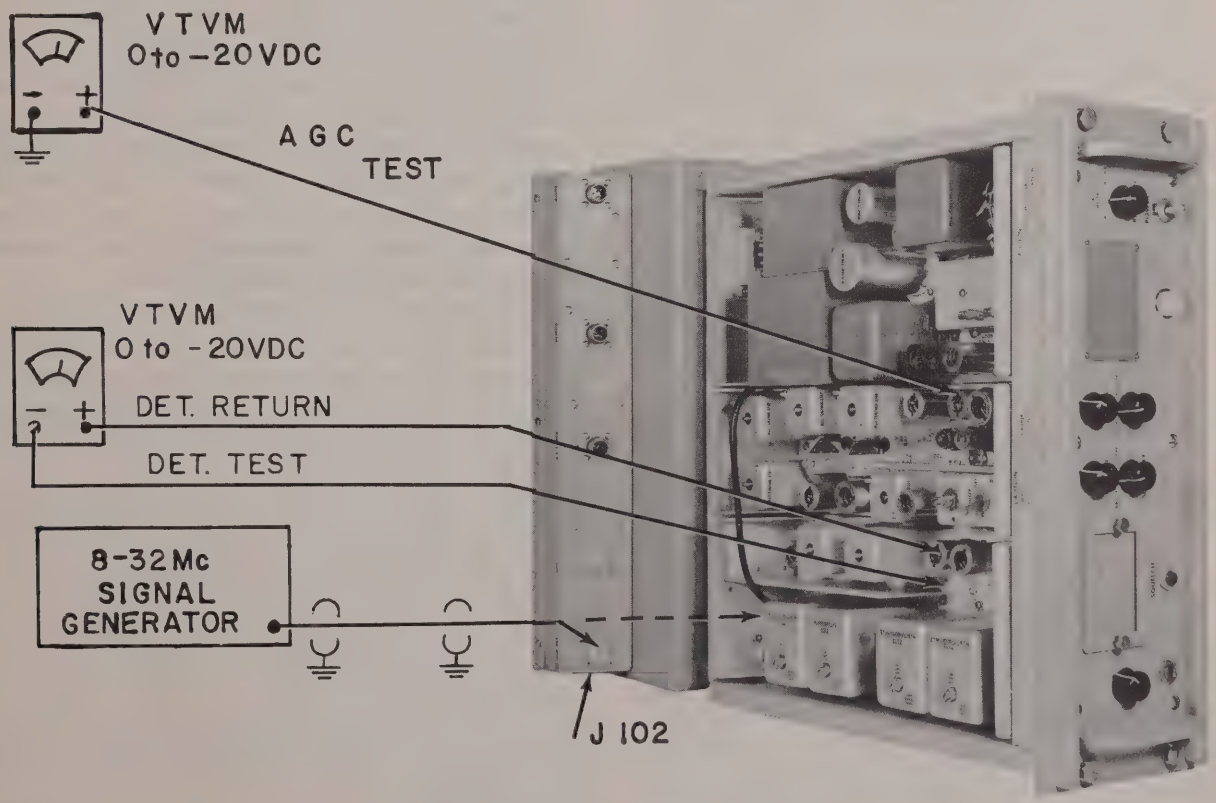


Figure 7-13. Signal Strength Test Set-up

6. REMOVAL AND REPLACEMENT OF CHASSIS ASSEMBLIES.

The AN/FRR-31 Radio Receiving Set is designed to permit removal and replacement of complete functional units, without the necessity of unsoldering any connections. This type of plug-in assembly permits replacement of defective units by non-technical personnel, thereby reducing to a minimum the amount of time the equipment must be out of operation. (See figure 3-4.)

a. RF CHASSIS AR101. (Figures 2-4 and 2-5.)

(1) This plug-in assembly, the left unit when viewed from the front (see figure 1-2) is held in place by its plug-in connector J101 (J401), and four Phillips head captive screws, one at each corner. To remove the unit, loosen the four captive screws and lift the chassis up by grasping the two angle brackets at each end. To replace, carefully align the plug-in connector, press down and tighten the captive screws.

(2) Unless a different channel frequency is desired, the RF stages, channel determining oscillator, and 2020 Kc IF, may be aligned prior to installation in the receiver, provided the alignment is performed in another receiver of the same type with normal operating voltages. It should not require further alignment, even though the unit is changed from one AN/FRR-31 receiver to another. If a different channel frequency is desired, the RF and channel determining oscillator stages must be realigned, in accordance with procedures of SECTION 7, paragraph 4.g.

b. IF CHASSIS AR201. (See figures 1-2, 2-9 and 2-10.)

(1) This plug-in assembly located in the center of the chassis assembly (see figure 1-2) is also held in place by its plug-in connector and four captive screws. Before removal, the clutch assembly connected between the IF chassis and the front panel SELECTIVITY control knob, must be disengaged by pulling on the SELECTIVITY knob until the shaft has been withdrawn to a point where the knob is approximately one inch away from the panel. An indent in the shaft will lock it in place. Removal and replacement procedure is now exactly as outlined in the previous paragraph for AR101.

(2) When either the IF chassis or the Audio/Power Supply chassis has been replaced, the clutches on the SELECTIVITY switch and RECEPTION switch can be properly engaged by pushing in firmly until the knob almost touches the panel. It can now be rotated in either direction while firmly pushing in, causing the clutch to engage. When the clutch has properly engaged, the knobs of these two controls can be rotated only to the positions indicated by the front panel markings.

(3) The 120 Kc IF amplifier section of this unit may be aligned in any AN/FRR-31 receiver, according to the procedure outlined in SECTION 7, paragraph 4.d. Thereafter, the aligned unit may be interchanged in any AN/FRR-31 receiver without further adjustments of the IF transformers. Operating controls on this unit, such as SQUELCH control (R217) and the NOISE LIMITER switch (S202), must be readjusted when interchanged with other receivers, as outlined in SECTION 3, paragraphs 4. a. (13) and 4. a. (14).

c. AUDIO/POWER SUPPLY CHASSIS AR301 (Figures 1-6, 2-16 and 2-17.)

(1) The removal procedure for this unit is the same as that for the IF chassis with the exception that the RECEPTION switch clutch assembly must be disengaged.

(2) This unit requires no alignment and is therefore interchangeable in any AN/FRR-26, 30 or 31 receiver. The AF LEVEL control (R301) must be adjusted after the unit is installed, in accordance with SECTION 3, paragraph 4. a. (12). Also, the power transformer primary link of TB301 must be properly selected, as outlined in paragraph 4. b. (2).

d. FRONT PANEL-FRAME ASSEMBLY (Figures 1-2 and 4-1).—The front and rear panel with the side pieces combine to form the framework into which the three plug-in assemblies are mounted. The front panel mounts the POWER switch, the neon indiator lamp, the SQUELCH test switch, the head-telephone jack, the BFO control, the RF GAIN control, the SENSITIVITY switch, the PHONES audio level control, the LOCAL-REMOTE switch and the RECEPTION switch. All are accessible for removal and replacement, as are the connector receptacles mounted on the shelf immediately back of the panel after removal of the three chassis. Mounted on the two shelves are 12 threaded standoffs, into which the captive screws of the plug-in assemblies are screwed to hold the units in place.

e. REAR FILTER COMPARTMENT. (See figure 1-3.)—This unit is a permanently mounted compartment at the rear of the receiver case. It contains the AC and audio RF filters, remote operation DC blocking capacitors, and provides receptacles into which the power, antenna, audio and remote cables are plugged. Access to this compartment requires the loosening of three Phillips type screws, and lifting off the cover. The large receptacle J504 (J302) is mounted to face the inside of the case and engages a matching receptacle on the rear of the Audio/Power Supply chassis when the receiver is inserted in its case. When any alignment, adjustment or other operation requires the removal of the receiver from its case, a test cable (W601) bridges the connections between the rear panel and the Audio/Power Supply chassis.

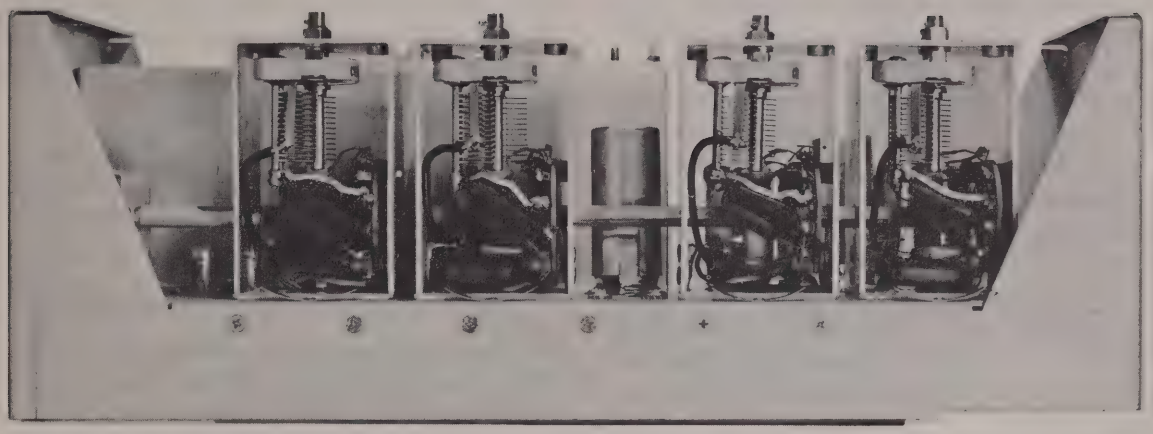


Figure 7-14. Side View of the RF Chassis with the Coil Cans Removed, Showing Details of the Coils and Switches

7. REMOVAL AND REPLACEMENT OF PARTS.

Removal and replacement of most parts of Radio Receiver AN/FRR-31 is a routine and simple procedure, involving only the removal of mounting screws or bolts and the unsoldering of connecting wires. A few parts, due to their location and/or construction, require special precautions or directions for replacement, as described in the following paragraphs:

a. POWER TRANSFORMER T301 (See figure 2-16).—Power transformer T301, located on the Audio/Power Supply chassis, is mounted by four 8-32 thread weldbolts on the transformer and hex nuts. Between the terminals on the bottom of this transformer is mounted the power transformer primary tap terminal board TB301. It is not necessary to remove TB301 when replacing the power transformer. Unsolder the terminal wires, being careful to keep them in their normal location for ease in replacement. Remove the four 8-32 hex nuts and lock washers and drop the transformer. Reverse this procedure for replacement. Wires leading to the transformer terminals are color coded; the colors are indicated on the receiver schematic, figure 7-19.

b. SELENIUM RECTIFIERS CR301 AND CR302 (See figure 2-17).—These units are mounted in a U channel aluminum bracket. The bracket is secured to the chassis by two 6-32 machine screws and it is not necessary to remove this bracket when replacing the seleniums. To change rectifiers, first remove the chassis, unsolder the connections to the unit(s) and then unscrew the 6-32 screws holding the selenium stack(s). Two access holes in the rear of the chassis can be used for screwdriver entry. Use a wrench or pliers to hold the nut. Pull the screws through the access holes and lift out the selenium stack. When replacing the selenium rectifier, it is important that the proper polarity be observed. The units used in the high voltage rectifier circuit have three terminals, but only the two end terminals are used. Bend the selenium terminals to avoid shorts between the two units.

c. BIAS SUPPLY SELENIUM CR303.—This unit is mounted on the Audio/Power Supply chassis and is accessible by removing the cover plate on which the spare fuse is mounted. This cover plate can be removed by loosening the two 6-32 captive screws, and lifting the cover plate off.

d. AUDIO OUTPUT TRANSFORMER T302 (See figure 2-16).—Removal of this part involves the unsoldering of connections, taking care to keep the connecting wires in their approximate locations and in the same order; and removal of four 6-32 hex nuts and lock washers which hold the unit to the chassis. When installing the new transformer, care must be taken to avoid reversing the transformer winding connections. Observe that the terminals are numbered on the bottom of the transformer. Make certain the leads are connected as shown on the schematic, figure 7-18.

e. REMOVAL OF IF SHIELD CANS.—In order to remove the shield cans from T101, T102, T201, T202, T203, T204 and T205, it is necessary to first remove the two 4-40 nuts and the two lock washers from the top of the studs. The shield can can then be lifted off the coil assembly. When the can has been removed, it will be noted that there are two short standoffs on each of the two support studs. Care should be taken that these are not lost and are in their proper place before the can is reseated. At the bottom of the IF coil base will be noted two grounding springs. These springs are necessary to provide a proper ground connection to the IF shield can. In replacing the shield can, care should be taken that these springs fit on the inside of the shield can.

f. RF SHIELD CAN REMOVAL.—When it becomes necessary to remove the RF shield cans from Z101, Z102, Z103 or Z104 for inspection of the RF coil assembly, they should be removed carefully by the following method. Two captive Phillips head 4-40 screws must first be loosened. It is suggested that one screw be loosened approximately two turns, the other screw then completely loosened until it has disengaged (not out of can) and then the first screw completely disengaged. The RF shield can is then lifted off. In replacing the RF shield can, it will be noticed that two grounding springs, permanently attached to the chassis, are provided for each shield can. Care should be taken to see that the sides of the RF shield can are centered and resting on these springs.

g. SWITCH INDEX AND SHAFT REMOVAL.—The index and shaft for the FREQUENCY BAND switch (S101) located on the RF chassis assembly, SELECTIVITY switch (S201) located on the IF assembly, and the RECEPTION switch (S301) located on the Audio/Power Supply chassis assembly, may be removed by the following method. It is necessary to first remove the individual chassis from the frame assembly. In order to do this, the four corner captive screws must be loosened, and in the case of the IF and Audio/Power Supply chassis, the clutch assemblies must be disengaged as outlined under paragraph 6.b.(1), REMOVAL AND REPLACEMENT OF CHASSIS. After the chassis has been removed, the switch shaft and index to be removed should be rotated so that the flatted side of the rear of the shaft is in a horizontal plane, so that it can be withdrawn through the slot in its end mounting bracket. When this has been done, the two 4-40 screws and shake washers, accessible from the end of the chassis assembly, should be removed, and the switch index and shaft can then be withdrawn. Since the switch decks are of fragile nature, special care should be taken during removal and replacement of any switch parts. It is not necessary to remove any switch decks before removal of the switch index assembly. When the switch shaft has been withdrawn, the individual switch decks should not at any time be rotated individually or otherwise, unless special care is taken to see that they are replaced in their original position. In reinserting the switch shaft, it may become necessary, particularly in the RF coil assemblies, to remove the shield can or cans, while inserting the shaft to prevent any damage to the switch decks, if the shaft does not pass with ease through the can assemblies.

h. PANEL KNOB CLUTCH ASSEMBLY.—Clutch assemblies are disassembled by the following procedure: Remove the chassis, taking care to disengage the SELECTIVITY or RECEPTION clutches by pulling out the knobs; loosen the two set screws on the clutch; slide the clutch off the end of the shaft; cup the fingers under the panel shaft bushing sub-assembly while slowly pulling out the shaft, and carefully remove the detent spring and two steel balls.

To reassemble a clutch assembly: Slide the shaft into the panel bushing, the end with the detent notch entering first, until the shaft end almost covers the two holes in the panel shaft bushing; insert the two steel detent balls; pull out the shaft so that the balls are almost completely in the holes so that the detent spring will not be damaged by excessive spreading when mounting; put the detent spring over the balls (spring loop down) and push shaft through completely. With the shaft pressed in so that it is detented in the normal operating position, slide on the clutch plate so that the notched end is about two inches from the back of the front panel. Tighten one set screw so that it barely holds the clutch to the shaft; pull out the shaft and insert the chassis. To obtain clearance between the clutch and the bushing of the switch, push in the shaft until the shaft is detented. Pull out the shaft to the "out" detent, remove the chassis and tighten the clutch set screws. Reinsert the chassis, reengage the clutch and then set the knob, if required, to point toward the correct panel marking.

8. CABLE ASSEMBLY DETAILS.

a. RF CABLES.—Supplied with the receivers is one length of AN type RG-58A/U coaxial cable with a type UG-88/U bayonet style connector at one end; the other end of the cable is permanently connected to the receptacle J302 on the Audio/Power Supply chassis. A short length of AN type RG-58A/U cable in the rear panel compartment connects J504 receptacle with the J501 connector. Unless subject to physical abuse or abnormal conditions of operation, these cables should require no further attention. Also supplied with the receiver is connector P501, which is a type UG-21B/U coaxial plug, for use with 72 ohm transmission line. To assist maintenance personnel in assembly of this plug and cable and to aid in the assembly of the inter-unit RG-58A/U cable and UG-88/U connector, should replacement become necessary, refer to figures 3-6 and 3-7 for details of fabrication.

b. AUDIO/REMOTE/AC CABLE DETAILS.—Connectors for these cables are supplied with the receiver, as listed in table 3-2. Since fabrication is comparatively simple, no specific details are given. To assure that the proper connector terminals are used for the lines, consult the receiver schematic, figure 7-18.

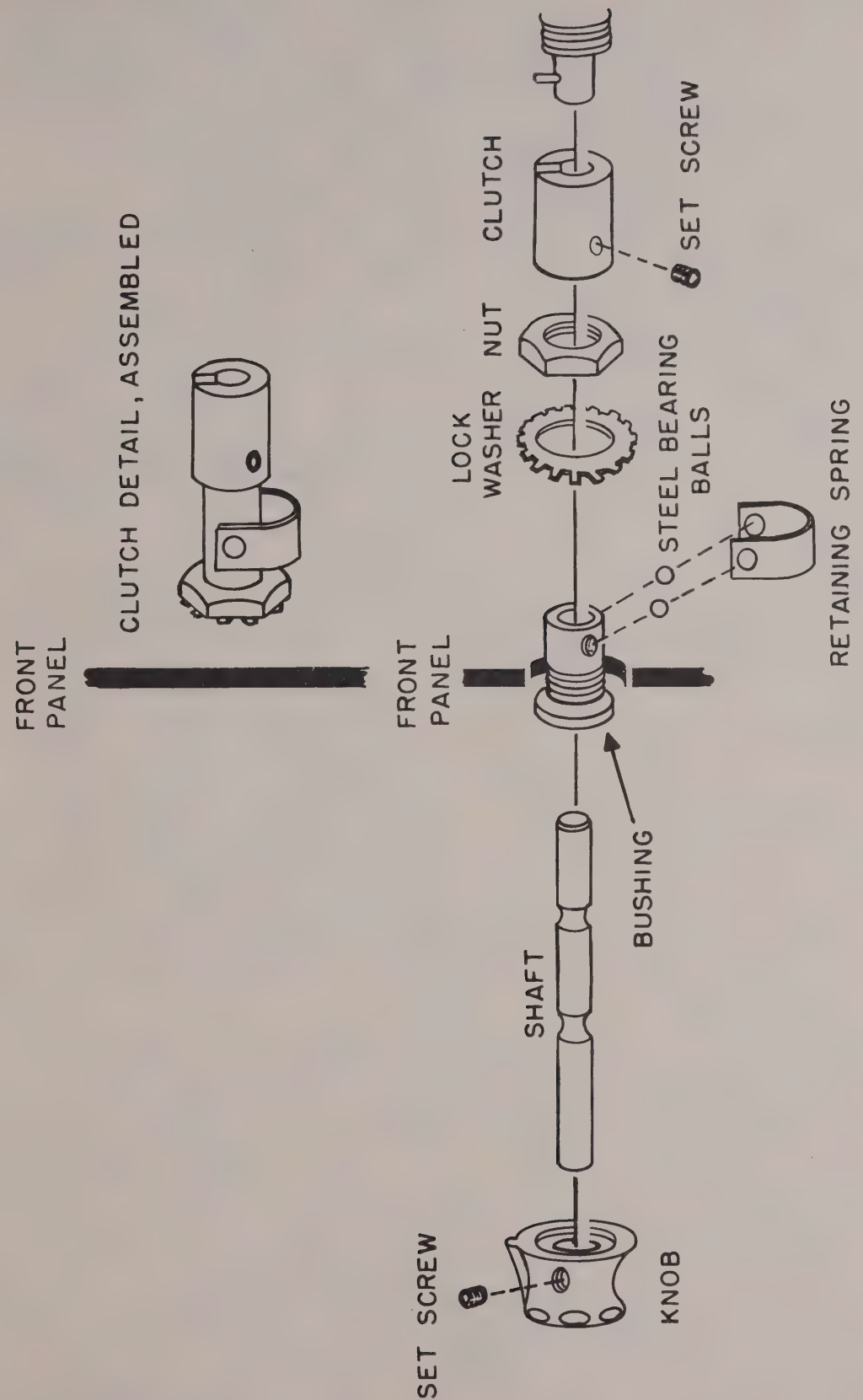


Figure 7-15. Exploded View of the Panel Knob Clutch Assembly

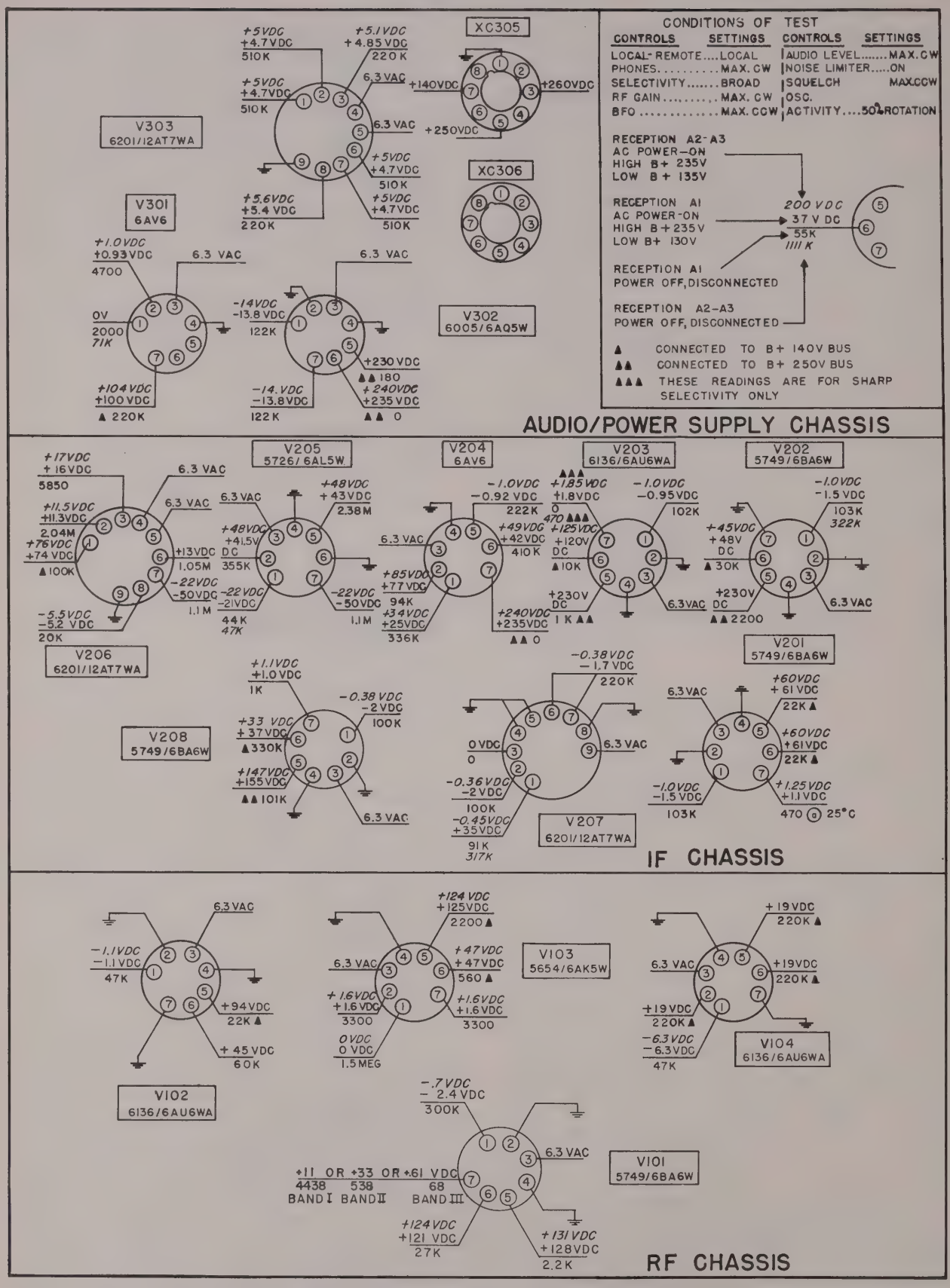


Figure 7-16. Bottom View of Tubes Sockets Showing Voltage and Resistance Measurements

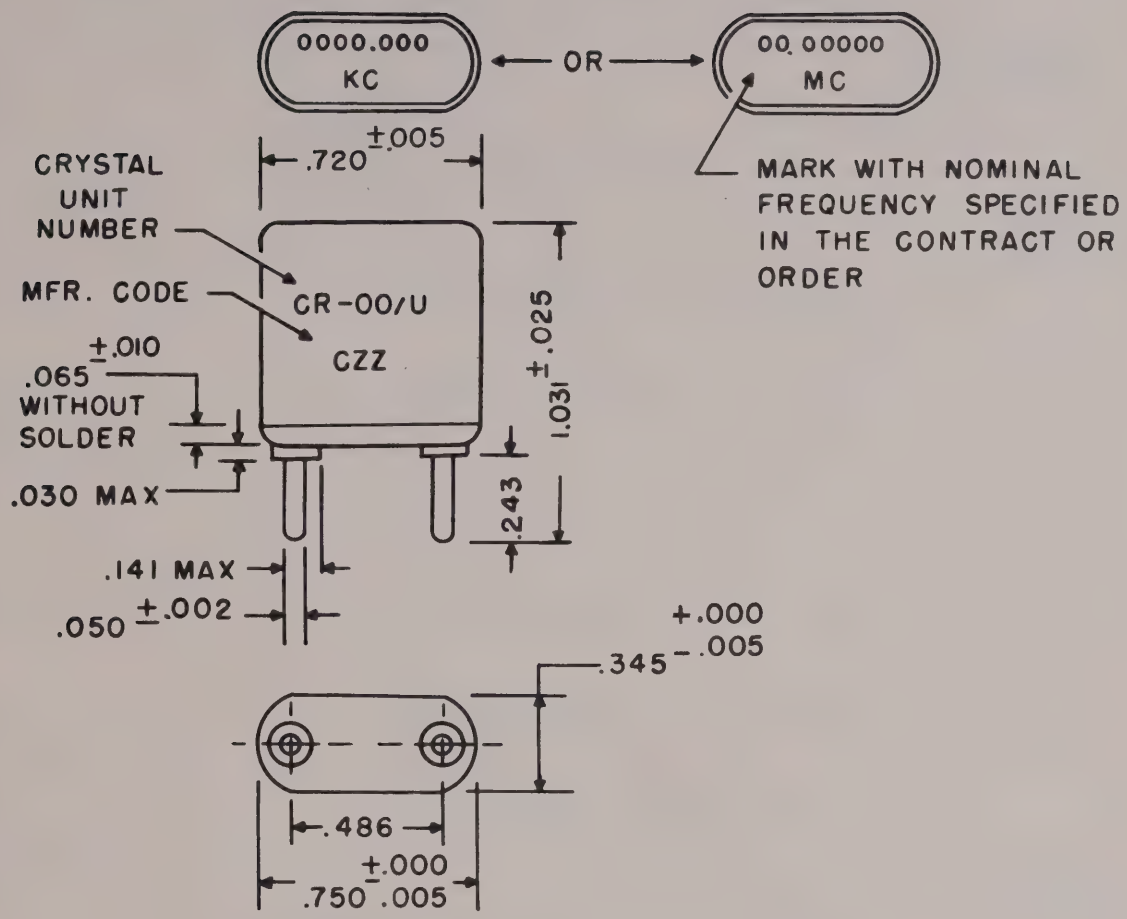


Figure 7-17. Outline and Data, Crystal Unit Holder HC-6/U

NOTES

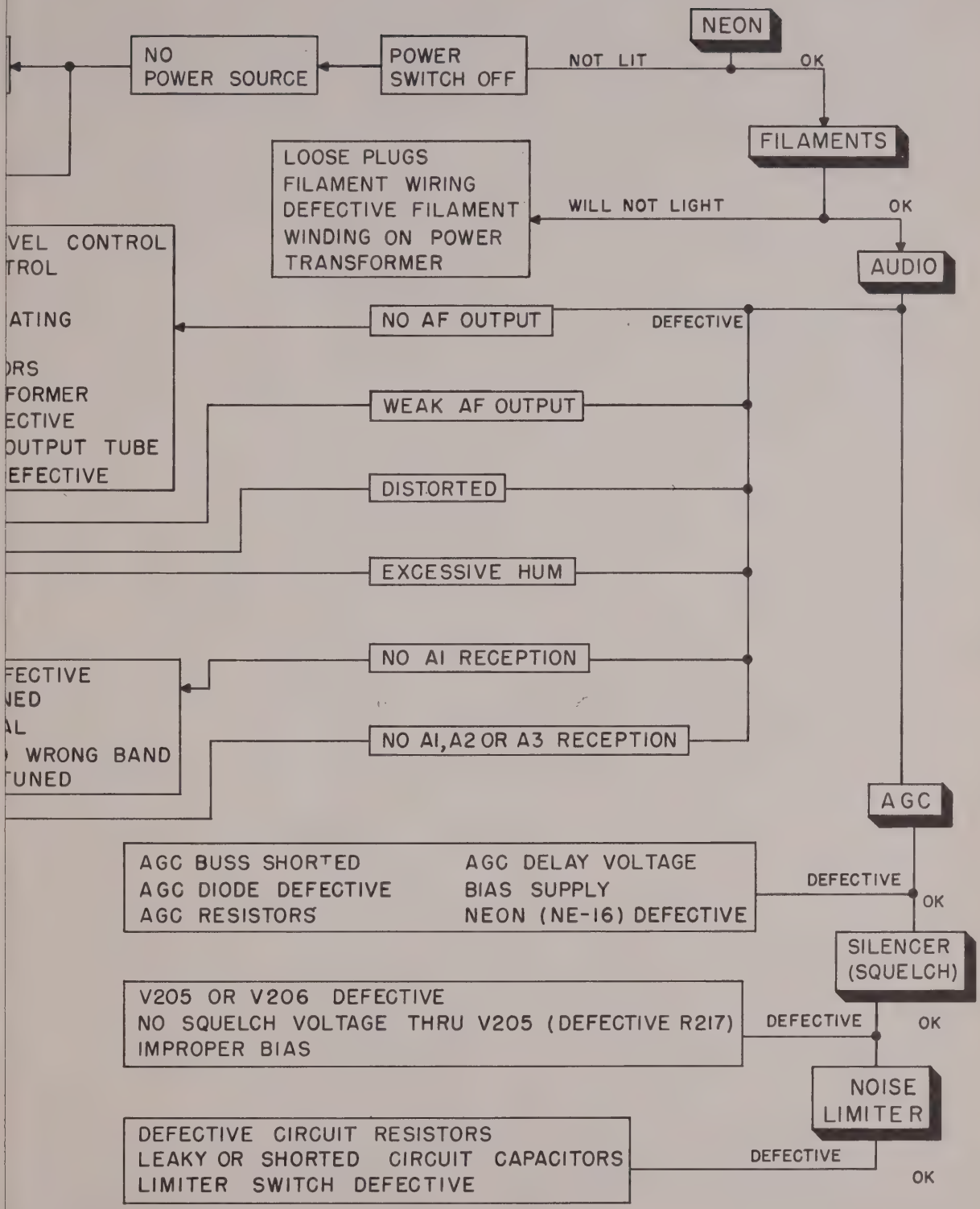


TABLE 7-12. TROUBLE SHOOTING CHART

NOTES

AN/FRR-31
PREVENTIVE MAINTENANCE
UNCLASSIFIED
NAVSHIPS 92835
Section 7

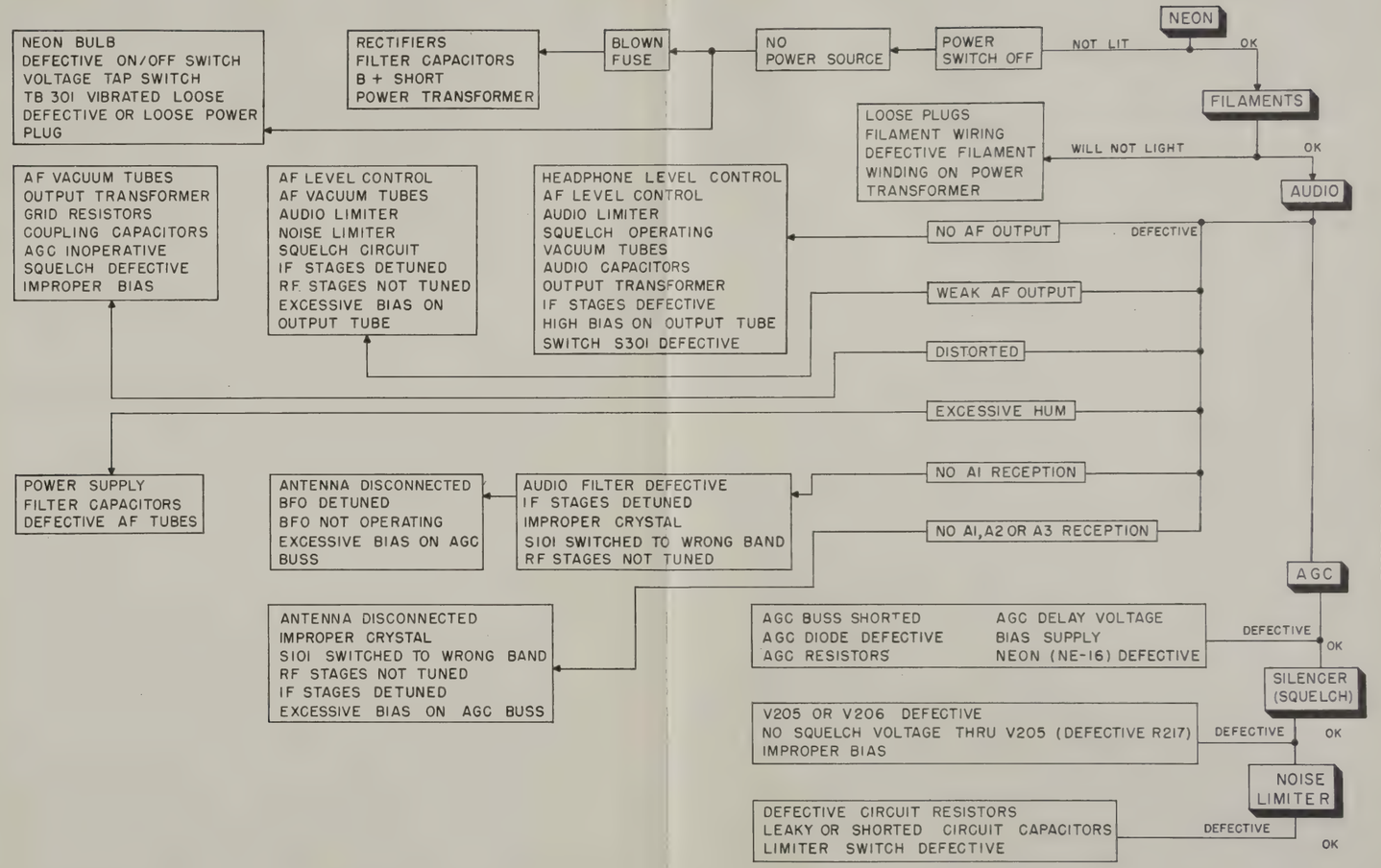


TABLE 7-12. TROUBLE SHOOTING CHART

TABLE 7-13. TUBE OPERATING VOLTAGES AND CURRENTS

TUBE TYPE	FUNCTION	SYMBOL	HEATER AC E	CATHODE E	GRID E	SCREEN E	SCREEN MA	SUPPRESSOR E	PLATE E	PLATE MA
JAN-5654/ 6AK5W	1st Mixer	V103	6.3	1.6		47		1.6	125	
JAN-5749/ 6BA6W	RF Amplifier	V101	6.3	Band I, 3.4 Band II, 1.6 Band III, 0.35	—0.7	90		0	116	
	2nd Mixer	V201	6.3	1.25	—1.0	60	0.8	0	60	2.6
	1st 120 Kc IF	V202	6.3	0	—1.0	45	0.8	0	230	2.2
	Buffer	V208	6.3	1.1	—2.0	33	0.3	0	147	0.75
JAN-6136/ 6AU6WA	Channel Det Osc	V102	6.3	0	1.1	45		0	94	
	1900 Kc Osc	V104	6.3	0	6.3	19		19	19	
	2nd 120 Kc IF	V203	6.3	Broad Sel 1.85 Sharp Sel 0	—1	125	1.05	—	230	2.35
JAN-6201/ 12AT7WA	1st Audio	V206		[1]1	[2]0	—	—	—	76	0.6 (pin 1)
	Squelch		6.3	—5.5	0 to —22	—			13	0.17 (pin 6)
	BFO	V207	6.3	0	—2	—	—	—	35	0.5 (pin 1)
	BFO Freq Control			0	1.7	—	—	—	[4]1.7	[4]0.4 (pin 6)
	Audio Limiter	V303	6.3	4.85	—				5	0.02 (pin 1)
				5.4	—	—	—	—	5	0.02 (pin 6)
JAN-5726/ 6AL5W	Noise Limiter-Squelch Diode	V205	6.3	—	—	—	—	—	—	[5]0.003 (pin 2)
				—	—	—	—	—	—	[4]0.05 (pin 7)
JAN-6AV6	Det AGC	V204	6.3	48	[3]0.6	—	—	—	240	1.6
	2nd AF	V301	6.3	1.0	0	—	—		104	0.4
JAN-6005/ 6AQ5W	Audio Output	V302		0	—14	240	4	—	230	35

(1). Measured across cathode resistor R223
(2). Measured across grid resistor R221
(3). Measured to cathode
(4). Maximum
(5). No signal (A2-A3)
(6). Measurements to ground and voltage AC line voltage 115, 60 cycles on 115 V primary tap no signal input.

TABLE 7-14. RATED TUBE CHARACTERISTICS

Tube Type	Filament Voltage	Filament Current	Plate Voltage	Grid Bias	Screen Voltage	Plate Current	Screen Current	AC Plate Resistance	Voltage Amplification Factor	Transconductance		Emission Test	
										Normal	Minimum	IS	
	V	A	V	V	V	MA	MA	OHMS	MU	MICRO	MHOS	MA	VOLT
JAN 5749/6BA6W	6.3	0.3	250	[1]—1	100	11.0	4.2	1.5 meg	—	4400	3600	60	20
JAN 6136/6AU6WA	6.3	0.3	250	—1.0	125	7.6	3.0	1.5 meg	—	5200	4150	60	20
JAN 6AV6	6.3	0.3	250	—2.0	N/A	[3]1.2 [2]1.0	N/A	[2]62500	100	1650	1250	[3]25 [2]0.8	[3]30 [2]10
JAN 5726/6AL5W[8]	6.3	0.3	117			9.0		300			40	40	10
JAN 6201/ 12AT7WA[8]	[4]12.6 [5]6.3	[4]0.15 [5]0.3	250	—2.0V	N/A	10.0	N/A	10900	60	5500	4500	50	10
JAN 6005/6AQ5W	6.3	0.45	250	—12.5	250	[6]45	[6]4.5	52000	218	4100	3000	100	30
JAN 5654/6AK5	6.3	0.175	180	[7]	120	7.7	2.4	0.69 meg	3500	5100	2900	[9]	[9]

(1). Cathode bias resistor 68 ohms
(2). For each diode
(3). Triode section
(4). Series
(5). Parallel
(6). Zero signal value
(7). Cathode bias resistor 200 ohms
(8). For each unit
(9). No values available

TABLE 7.15 COIL WINDING DATA — ALL WIREWOUND PARTS, EXCEPT RESISTORS

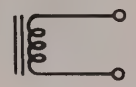
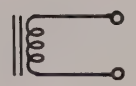
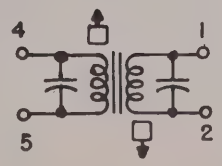
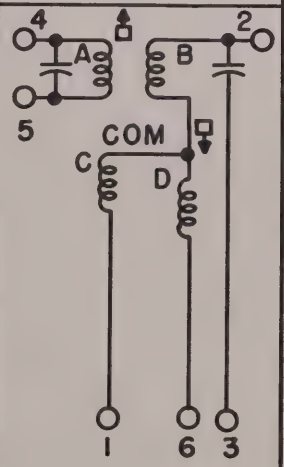
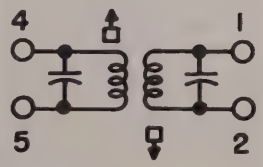
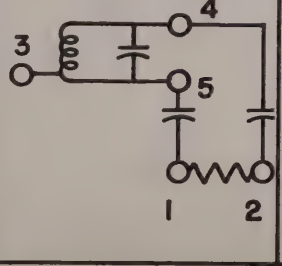
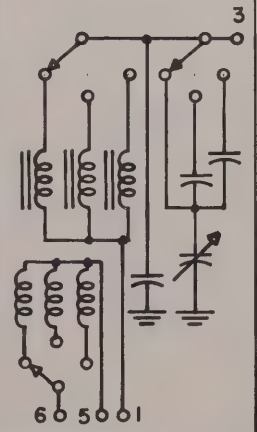
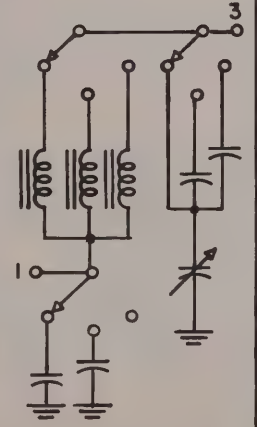
Circuit Symbol	COMCO Drawing Number	Schematic Diagram	Coil Form	Winding	Wire and Size (AWG)	No. of Turns and Location of Taps	D-C Resistance in OHMS	Inductance	"Q" and Frequency	Remarks
L301	327-C-302		Laminated Iron	Choke Multi-layered	#30 enameled	3000	150 ±15% at 25°C	10h, ±50% —20% at 10v, 60 cycles; 0.1 amp DC	Not Applicable	Stancor Type 88C2
L401	22-035		Powdered Iron	Universal	#36 Single Celanese Nylon Enameled	275	7.6	430 μh	Q:30 min. Frequency: Not Applicable	Wilco Corp. Type 3430-15
L501 L502 L505 L506	327-R-E-309		3 Powdered Iron Slugs Bolted together	3 Section Universal	#24 Double Nylon	90 per Section	1.17	1 mh ±20% at 790 Kc	30 ±20% at 790 Kc	
L503 L504 L507 L508	327-R-E-308		Bakelite Pigtail Slug	Close Solenoid	#24 Double Nylon	24	0.065	1 μh	Not Applicable	
T101 T102	331-R-301		Rolled Tubing Type PBE-Tr Adjustable Powdered Iron Slugs	Primaries: Universal L113, L115 Secondaries: Universal L114, L116	15/44 Litz 15/44 Litz	80 80	4-5 2.2 1-2 2.2		Pri: 115-120 at 2020 Kc	Operating Frequency 2020 Kc, Identical Pri and Sec Windings; 75 μμf capacitor in shunt with Pri and Sec windings

TABLE 7-15. (Continued) COIL WINDING DATA — ALL WIREWOUND PARTS, EXCEPT RESISTORS

Circuit Symbol	COMCO Drawing Number	Schematic Diagram	Coil Form	Winding	Wire and Size (AWG)	No. of Turns and Location of Taps	D-C Resistance in OHMS	Inductance	"Q" and Frequency	Remarks
T201 T202 T203	326-R-312		Rolled Tubing Type PBE-T_r; Adjustable Powdered Iron Slugs	Coil A: (Pri) Universal L202, L204 L206	10/44 Litz	650	4-5 31	3.65 mh at 250 Kc	Pri: 59 at 120 Kc	Operating Frequency: 120 Kc
				Coil B: (Sec) Universal L203, L205 L207	10/44 Litz	635	C-2 30	3.6 mh at 250 Kc	Sec: 58 at 120 Kc	330 $\mu\mu$f capacitor in shunt with Pri. and Sec. Windings
				Coil C: Universal (p/o Sec)	10/44 Litz	110	3-1 4.5	0.18 mh at 780 Kc		
				Coil D: Universal (p/o Sec.)	10/44 Litz	80	C-6 3.15	82 μh at 2.5 Mc		
T204	326-R-310		Rolled Tubing Type PBE-T_r; Adjustable Powdered Iron Slugs	Pri: L208 Universal	10/44 Litz	660	4-5 30	3.6 mh at 250 Kc	Pri: 29 at 120 Kc	Operating Frequency: 120 Kc; Identical Pri and Sec. windings; 330 $\mu\mu$f capacitor in shunt with Pri. and Sec. Windings
				Sec: L209 Universal	10/44 Litz	660	1-2 30	3.6 mh at 250 Kc	Sec: 29 at 120 Kc	
T205	326-R-309		Rolled Tubing Type PBE-T_r; Adjustable Powdered Iron Slug	L201 Universal	10/44 Litz	675 tapped at 70 from start	4-5 32 3-5 2.2	4-5: 4.4 mh at 250 Kc	62 at 120 Kc	Operating Frequency: 120 Kc; 330 $\mu\mu$f capacitor in shunt with Windings 47 $\mu\mu$f, 0.01 μf Fixed Capacitors; 220K Fixed Resistor

Circuit Symbol	COMCO Drawing Number	Schematic Diagram	Coil Form	Winding	Wire and Size (AWG)	No. of Turns and Location of Taps	D-C Resistance in OHMS	Inductance	"Q" and Frequency	Remarks
T301	327-C-302		Core: .019" Dynamo Annealed; Stack: 1 5/8" Interleaved 3x3	Pri.	23 Enameled	370, Tap 310, 340	1-2 3.48 1-3 3.85 1-4 4.23	Voltages: #1-2 105V #1-3 115V #1-4 125V	Not Applicable	Stancor Type 88 P5 Electrostatic Shielding between windings #Input voltages *Output voltages
				Shield.	.001" Cooper	1				
				Sec. #1	32 Enameled	1400 Taps 700 762	5-8 157 6-7 7	*5-6 225V *6-7 75V *6-8 225V		
				Sec. #2	15 Enameled	20	9-10 .05 .058	*9-10 6.3V 5 Amps		
T302	327-C-301		Core: .019" Dynamo Annealed; Stack: 3/4" Butt, air Gap .001	Pri.	35 Enameled	1700	1-2 180	Load Impedance 1-2 5000 Ohms	Not Applicable	Stancor Type 88 A10 Electrostatic Shielding between windings
				Shield	.001" Cooper	1				
				Sec. #1	30 Enameled	210	3-6 17			
				Sec. #2	30 Enameled	210		3-6 300 Ohms		
				Sec. #3	30 Enameled	60	7-8 2.5	7-8 600 Ohms		

TABLE 7-15. (Continued) COIL WINDING DATA — ALL WIREWOUND PARTS, EXCEPT RESISTORS

Circuit Symbol	COMCO Drawing Number	Schematic Diagram	Coil Form	Winding	Wire and Size (AWG)	No. of Turns and Location of Taps	D-C Resistance in OHMS	Inductance	"Q" and Frequency	Remarks
Z101	331-R-302		Pri: Powdered Iron	Primaries: Close Wound Solenoid						RF Coil with Antenna Winding; Operating Frequency: Band I: 8-16 Mc; Band II: 16-24 Mc; Band III: 24-32 Mc; 7.5-99 μμf variable capacitor in shunt with all windings; 75 μμf Fixed Series capacitor on Band II; 36 μμf Fixed Series capacitor on Band III; 7 μμf Fixed Padder capacitor on all Bands.
				Band I	#24 DNX	1 3/4	0.13	1.46 μh		
				Band II	#24 DNX	1 1/8	0.1	0.09 μh		
				Band III	#24 DNX	3/4	0.08	0.085 μh		
			Sec: Powdered Iron	Secondaries: Space Wound						
				Band I L101	#24 DNX	22	0.5	3.84 μh at 7.9 Mc	215 to 225 at 7.9 Mc	
				Band II L102	#24 DNX	14	0.32	1.78 μh at 7.9 Mc	188 to 196 at 7.9 Mc	
				Band III L103	#24 DNX	10 3/4	0.29	1.06 μh at 25 Mc	170 to 178 at 25 Mc	
Z102	331-R-303		Powdered Iron	Space Wound Solenoid:						Operating Frequency: Band I: 8-16 Mc; Band II: 16-24 Mc; Band III: 24-32 Mc; 7.5-99 μμf variable capacitor in shunt with all windings; 75 μμf Fixed Series capacitor on Band II; 39 μμf Fixed Series capacitor on Band III; one common 1200 μμf bottom coupling capacitor with a shunt fixed 0.01 μf capacitor on Band I and a fixed 0.02 μf on Band II
				Band I L104	#24 DNX	22	0.5	3.84 μh at 7.9 Mc	215 to 225 at 7.9 Mc	
				Band II L105	#24 DNX	14	0.32	1.78 μh at 7.9 Mc	188 to 196 at 7.9 Mc	
				Band III L106	#24 DNX	10 3/4	0.29	1.06 μh at 25 Mc	170 to 178 at 25 Mc	

Circuit Symbol	COMCO Drawing Number	Schematic Diagram	Coil Form	Winding	Wire and Size (AWG)	No. of Turns and Location of Taps	D-C Resistance in OHMS	Inductance	"Q" and Frequency	Remarks
Z103	331-R-304		Powdered Iron	Space Wound Solenoid:						Operating Frequency: Band I: 8-16 Mc; Band II: 16-24 Mc; Band III: 24-32 Mc; 7.5-99 $\mu\mu f$ variable capacitor in shunt with all Windings; 75 $\mu\mu f$ Fixed Series capacitor on Band II; 39 $\mu\mu f$ Fixed Series capacitor on Band III; 1200 $\mu\mu f$ Fixed Bottom Coupling capacitor
				Band I L107	#24 DNX	22	0.5	3.84 μh at 7.9 Mc	215 to 225 at 7.9 Mc	
				Band II L108	#24 DNX	14	0.32	1.78 μh at 7.9 Mc	188 to 176 at 7.9 Mc	
				Band III L109	#24 DNX	10 3/4	0.29	1.06 μh at 25 Mc	170 to 178 at 25 Mc	
Z104	331-R-305		Powdered Iron	Space Wound Solenoid:						Operating Frequency: Band I: 8-16 Mc; Band II: 16-24 Mc; Band III: 24-32 Mc; 7.5-99 $\mu\mu f$ variable capacitor in Shunt with all windings; 75 $\mu\mu f$ Fixed Series capacitor on Band II; 43 $\mu\mu f$ Fixed Series Capacitor on Band III, with a fixed common coupling capacitor of 1200 $\mu\mu f$ with a fixed shunt, 0.01 μf capacitor on Band I and a fixed 0.02 μf on Band II
				Band I L110	#24 DNX	22	0.5	3.84 μh at 7.9 Mc	215 to 225 at 7.9 Mc	
				Band II L111	#24 DNX	14	0.32	1.78 μh at 7.9 Mc	188 to 176 at 7.9 Mc	
				Band III L112	#24 DNX	10 3/4	0.29	1.06 μh at 25 Mc	170 to 178 at 25 Mc	

NOTES

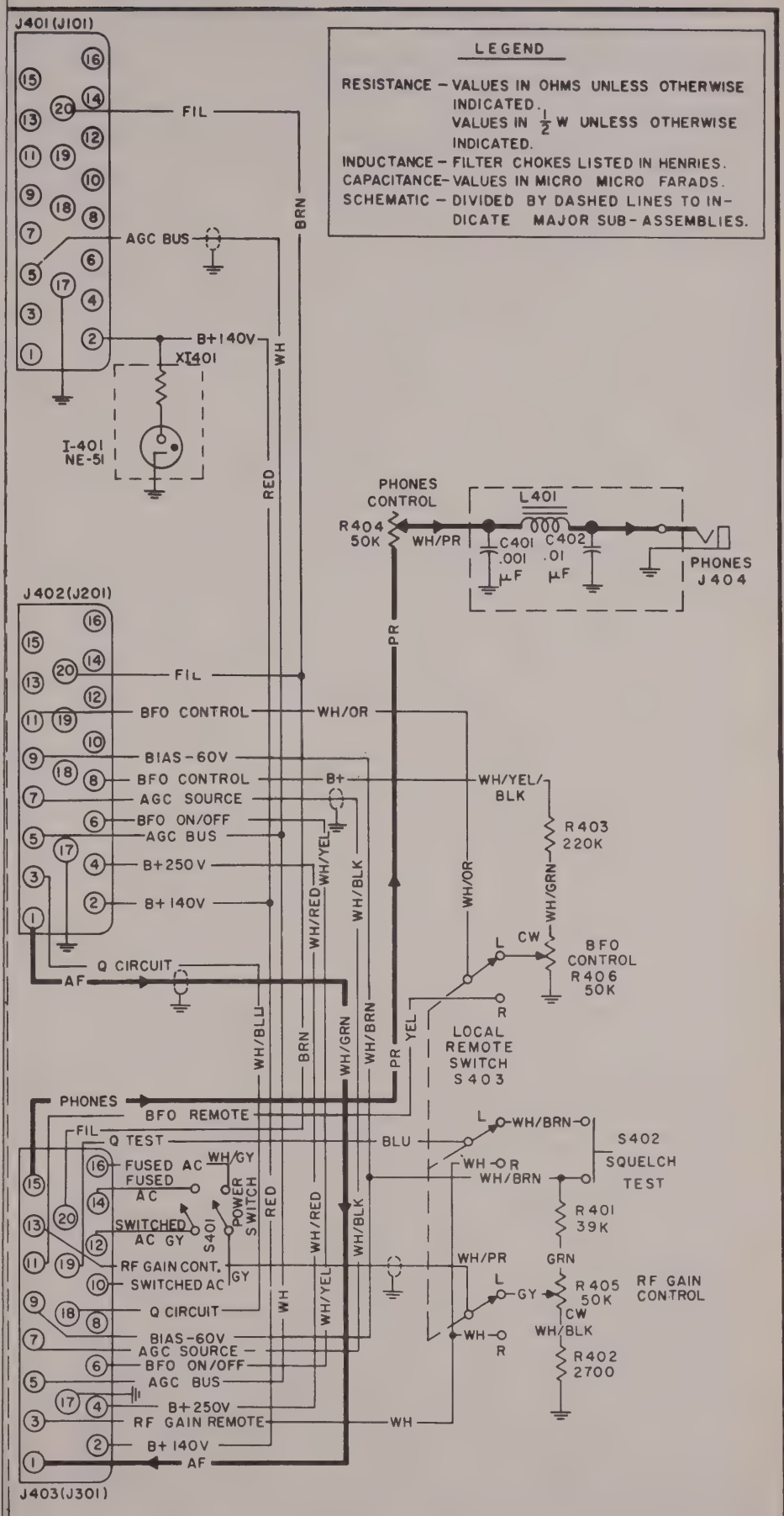


Figure 7-18. Overall Schematic—Radio Receiver R-777/FRR-31

NOTES

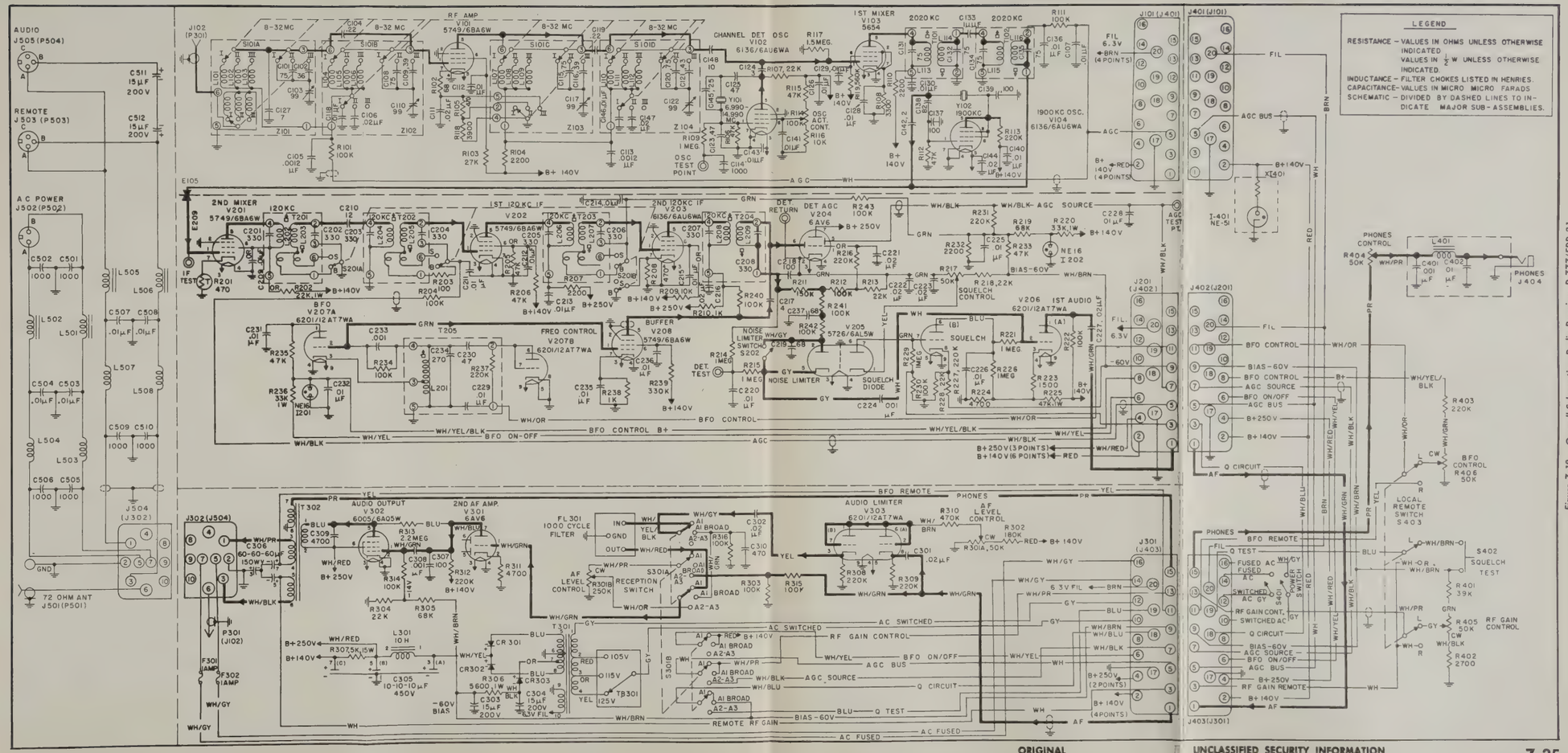
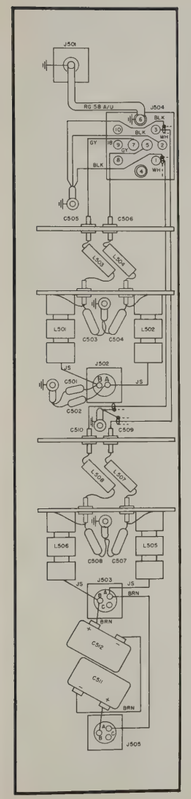
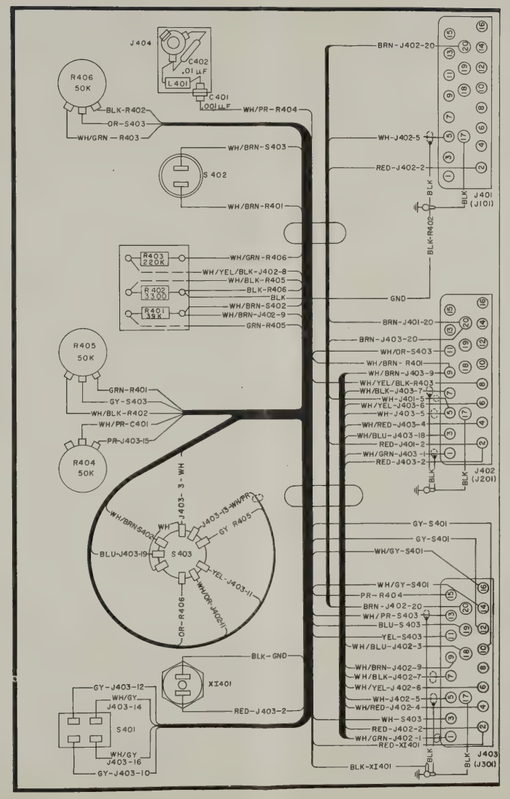


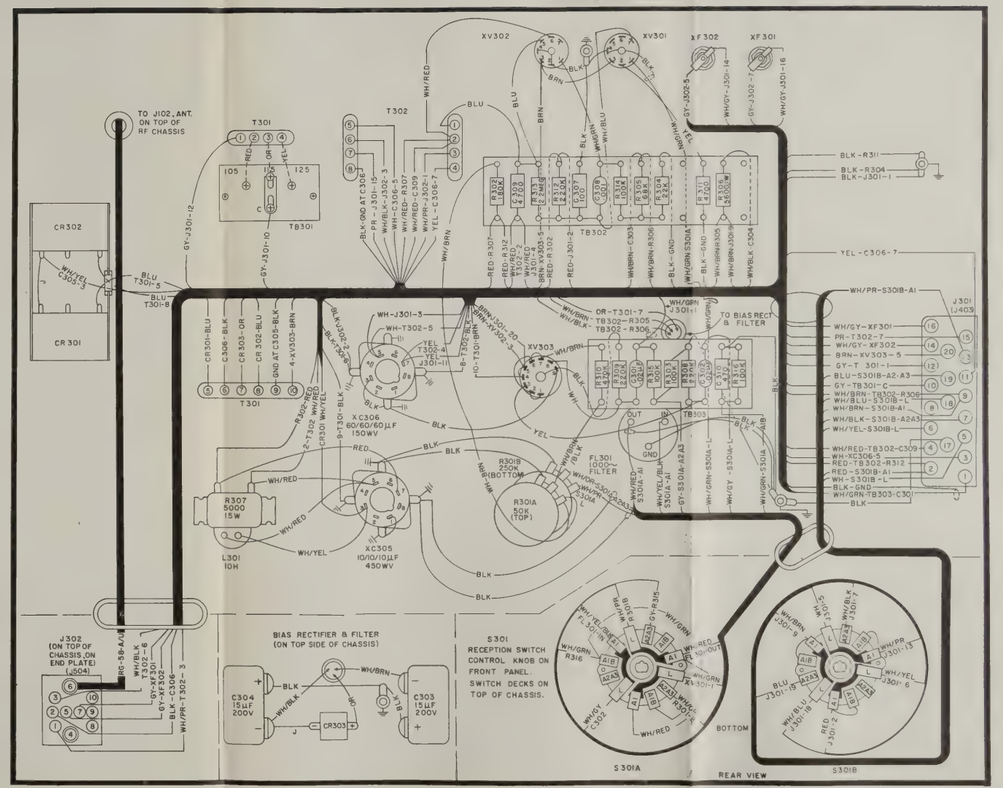
Figure 7-18. Overall Schematic—Radio Receiver R-777/FRR-31

1. ALL HOOK-UP WIRES TO BE * 22 (7/30 STRANDED), 1/64 INSULATION (1000V) TYPE SRIR, PER JAN-C-76, EXCEPT AS NOTED (J504, PINS 5 AND 7).
2. ALL SHIELDED HOOK-UP WIRES TO BE * 22 (7/30 STRANDED), 1/64 SRIS INSULATION, 3/64 SHIELDED BRAID, 1/64 PLASTIC JACKET OVERALL
3. "J" AND UNMARKED JUMPERS INDICATE * 22 SOLID BARE TINNED COPPER EXCEPT JUMPER FROM J102 TO Z101, WHICH IS *18 AND JUMPER FROM Z104 TO V103 WHICH IS * 16
4. "JS" INDICATES JUMPER PER NOTE 3 WITH * 22 FIBERGLASS SLEEVING DOUBLE SATURATED PER IRVINGTON VARNISH INSULATING COMPANY

Figure 7-19. Wiring Diagrams—Radio Receiver R-777/FRR-31







1. ALL WIRE TO BE M 81 (7/30 STRANDS), /24 INSULATION (600V) TYP. SHA PER JAN-C-76, EXCEPT AS NOTED: -26A, MIL-W-16878/4, TYPE E, 20 AWG, 7/28 STRANDS, /24 INSULATION, 7/64" O.D., 600V, 105°C, SILICONE RUBBER INSULATION, 3/64" WALL, BRAID, /24 FIBERGLASS, SILICONE RUBBER IMPREGNATED, 11/64" O.D. OVERALL.
2. ⊙ AND UNMARKED JUMPERS: MODEL M 22759/16-20 BARE TINNED COPPER WIRE, 20 AWG, 7/28 STRANDS, INSULATED WITH TEFLON, 1/16" O.D. FROM THOMAS & BETTS CO., ELIZABETH, N.J.
3. ⊙ AND UNMARKED WIRES: M 81 WITH ◆ : /24 FIBERGLASS, SILICONE RUBBER IMPREGNATED, 1/8" O.D. FROM THOMAS & BETTS CO., ELIZABETH, N.J.
4. ⊙ AND UNMARKED TWO TWISTED WIRES: M 81 WITH ▲ : /24 FIBERGLASS, SILICONE RUBBER IMPREGNATED, 1/8" O.D. FROM THOMAS & BETTS CO., ELIZABETH, N.J.

Figure 7-19. Wiring Diagrams—Radio Receiver R-777/FRR-31

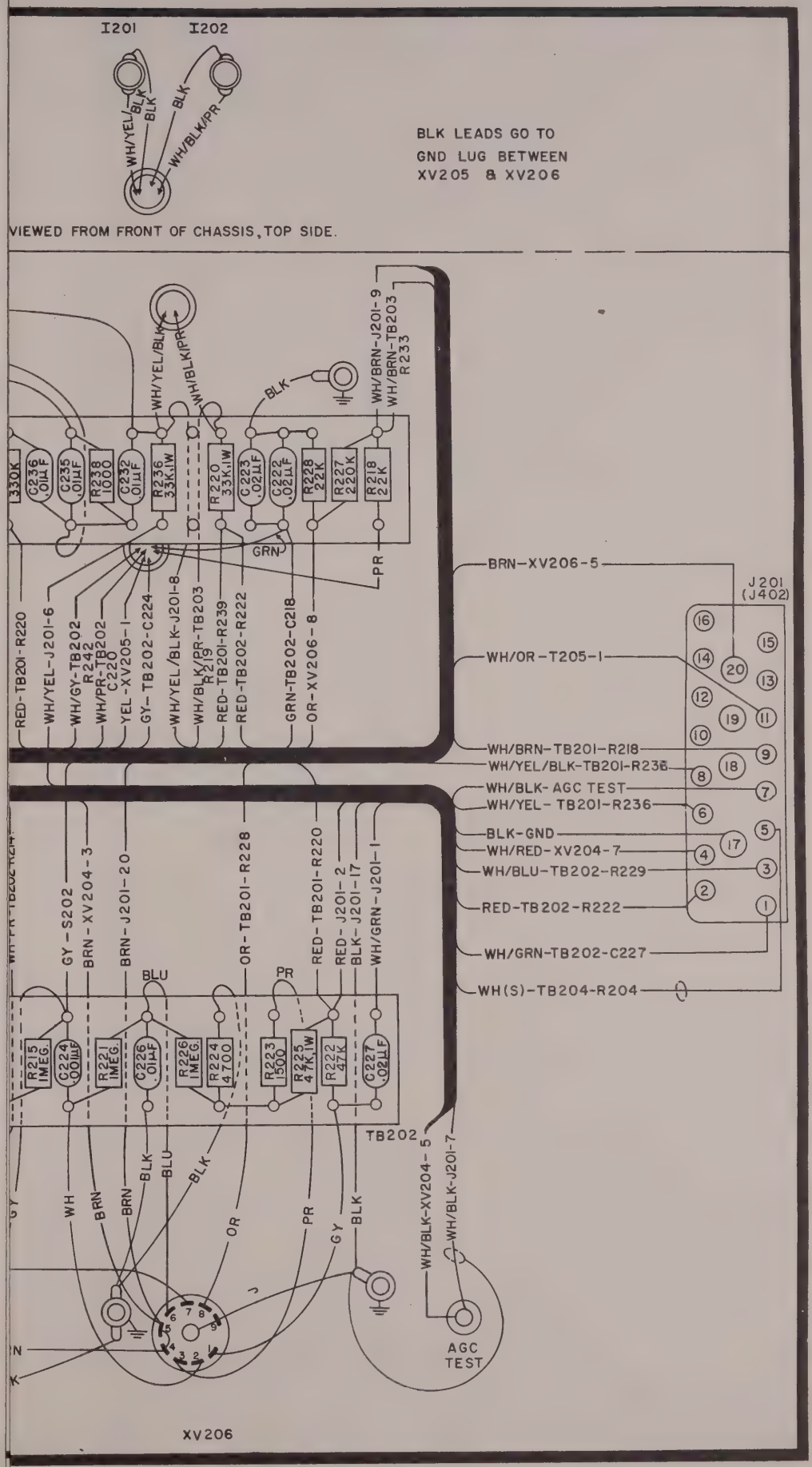
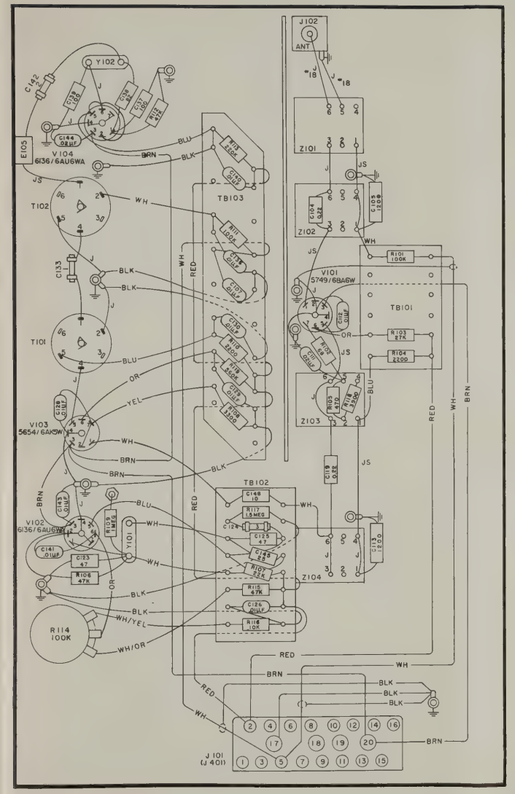


Figure 7-20. Wiring Diagrams—Radio Receiver R-777/FRR-31



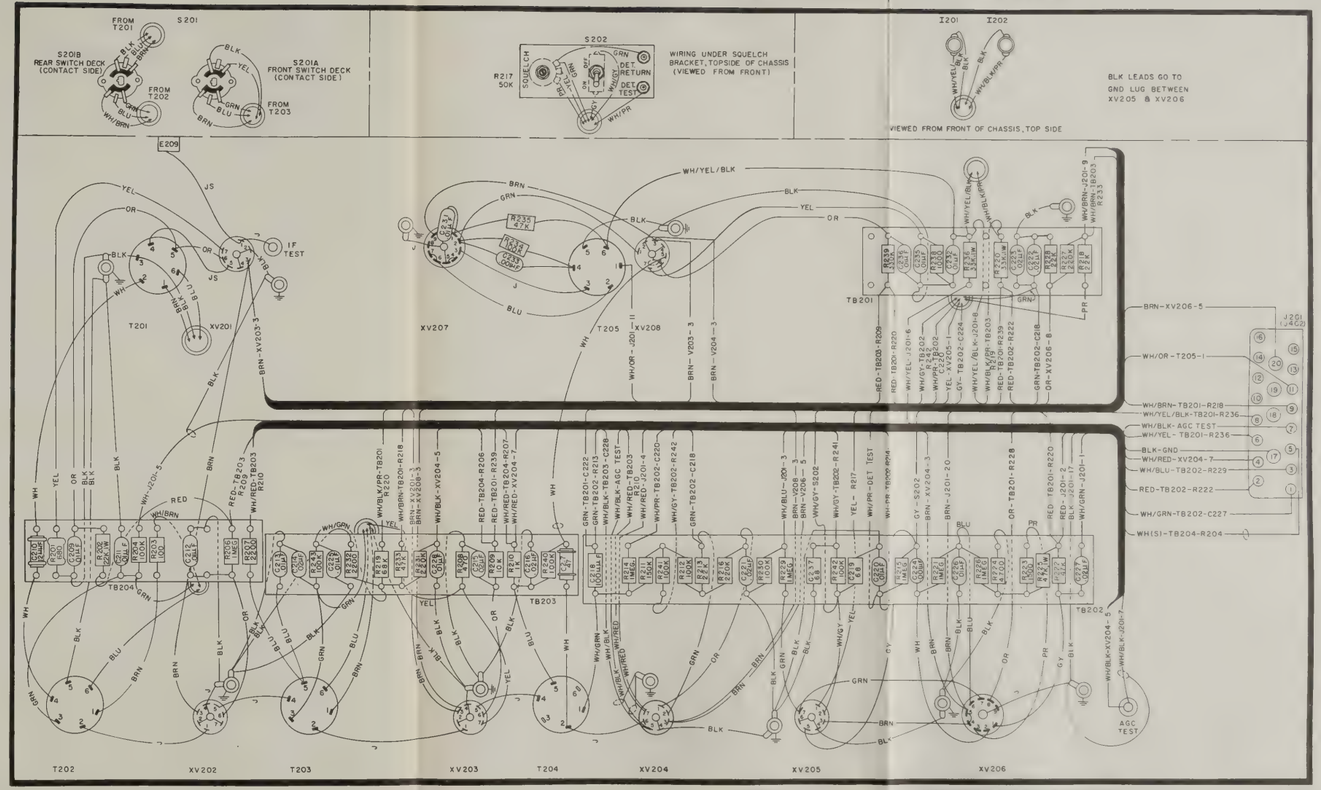


Figure 7-20. Wiring Diagrams—Radio Receiver R-777/FRR-31

SECTION 8
PARTS LIST AND MISCELLANEOUS TABLES

TABLE 8-1. LISTS OF MAJOR UNITS

SYMBOL GROUP	QUANTITY	NAME OF MAJOR UNIT	DESIGNATION
101-699	1	Radio Receiving Set including one radio receiver	AN/FRR-31 R-777/FRR-31

TABLE 8-2. TABLE OF REPLACEABLE PARTS
TABLE 8-3. CROSS REFERENCE PARTS LIST
TABLE 8-4. APPLICABLE COLOR CODES AND MISCELLANEOUS DATA
TABLE 8-5. LIST OF MANUFACTURERS
INDEX

TABLE 8-2. TABLE OF REPLACEABLE PARTS

REFERENCE DESIGNATION	STOCK NUMBERS STANDARD NAVY	NAME AND DESCRIPTION	LOCATING FUNCTIONS
AR101	N16-A039380-2140	AMPLIFIER-OSCILLATOR: plug-in assembly; includes RF Amplifier in 3 Bands (Band I: 8-16 Mc, Band II: 16-24 Mc, Band III: 24-32 Mc), Channel Determining Crystal Oscillator 6.990 Mc-14.990 Mc, 1900 Kc Crystal Oscillator, 2020 Kc IF Amplifier and RF Amplifier Band Switch, screwdriver turned from rear of chassis; voltage requirements: 6.3 v AC, +140 v DC; input impedance 72 ohms; signal strength 1-8 microvolts; over-all max dim 12 7/8" lg x 5" wide x 4 9/16" high; plugs into receptacle connector mounted on front frame; held in place by four no. 10-32 thread Phillips truss head captive machine screws (2 at front and 2 at rear) which thread into clinch standoffs mounted on frame; aluminum chassis; major components identified by symbol numbers silk-screened on chassis, top and bottom; RF Amplifier coils calibrated in Mc in all three Bands and silk-screened on top of shield cans; mfr CCI, Dwg no. 331-R-102; consists of C101 through C148, E101 through E106, J101, J102, L101 through L116, R101 through R119, S101, T101, T102, TB101 through TB103, XV101 through XV104, XY101, XY102, Z101 through Z104	RF subassembly
AR201	N16-A039380-2136	AMPLIFIER-OSCILLATOR-DETECTOR: plug-in assembly; includes 120 Kc IF Amplifier, Detector, Automatic Gain Control circuit, Noise Limiter stage, Squelch, Beat Frequency Oscillator, BFO Frequency Control and Buffer, BROAD-SHARP Selectivity switch; voltage requirements: 6.3 v AC, +250 v, +140 v, —60 v DC; over-all max dim 12 7/8" lg x 4" wide x 4 9/16" high; plugs into receptacle connector mounted on front frame; held in place by four no. 10-32 thread Phillips truss head captive machine screws (2 at front and 2 at rear) which thread into clinch standoffs mounted on frame; aluminum chassis; major components identified by symbol numbers silk-screened on chassis, top and bottom; NOISE LIMITER switch, SQUELCH control and test points accessible on top of chassis; SELECTIVITY switch shaft disengages from clutch assembly on front panel for removal of chassis from frame; mfr CCI, Dwg nos. 326-R-103, 326-R-837, 326-R-844; consists of C201 through C237, E201 through E210, J201, L201 through L209, R201 through R243, S201, S202, T201 through T205, TB201 through TB204, XI201, XI202, XV201 through XV208	IF subassembly

AR301	N16-A039390-6175	AMPLIFIER-POWER SUPPLY: plug-in assembly; includes: Audio Amplifier with output transformer; AC operated Power Supply with power transformer, full-wave selenium rectifier and choke input-capacitor filter system; adjustable Audio Level control and 1000 cycle Audio Band Pass filter for A1 reception; Bias and High Voltage filter; Reception Switch or A1, A1 BROAD, A2-A3 reception; voltage requirements: 105, 115 or 125 v AC, 50-60 cycles; Power Supply output 6.3 v AC and 250,140, —60 v DC; supplies power to all units of AN/FRR-26, 30 and 31 Radio Receiving Sets; Audio Amplifier provides 200-600 and 600 ohm impedance outlets; over-all max dim 12 7/8" lg x 5 15/16" wide x 4 9/16" high; plugs into receptacle connector mounted on front frame; held in place by four no. 10-32 thread Phillips truss head captive machine screws (2 at front, 2 at rear) which thread into clinch standoffs mounted on frame; aluminum chassis; major components identified by symbol numbers silk-screened on chassis, top and bottom; AF Level control and fuses accessible on top of chassis; short coaxial cable from J302 to P301 permits connection to RF chassis assembly; RECEPTION Switch shaft disengages from clutch assembly on front panel for removal of chassis from frame; terminal board on bottom of chassis permits matching power transformer primary to 105, 115 or 125 v AC line; mfr CCI, Dwg nos. 326-R-104, 326-R-848, 326-R-853; consists of C301 through C310, CR301 through CR303, E301 through E304, F301 through F303, FL301, J301, J302, L301, P301, R301 through R316, S301, T301, T302, TB301 through TB303, XC301, XC302, XF301, XF302, XV301 through XV303	Audio/Power Supply subassembly
C101	N16-C028130-9801	CAPACITOR, FIXED, MICA DIELECTRIC: 75 $\mu\mu$f $\pm$5%; 500 wv DC; Type CM20C750J, per Spec MIL-C-5A; p/o Z101	Z101, Band II, series padder
C102	N16-C027286-9001	CAPACITOR, FIXED, MICA DIELECTRIC: 36 $\mu\mu$f $\pm$5%; 500 wv DC; Type CM20C360J, per Spec MIL-C-5A; p/o Z101	Z101, Band III, series padder
C103	For replacement use SNSN N16-C061140-8110 Modified as indicated in description	CAPACITOR, VARIABLE, AIR DIELECTRIC: plate meshing type; 7.5 $\mu\mu$f to 99 $\mu\mu$f; 600 V (rms) 60 cycles AC; mfr CFW: Type CT1C100, per Spec JAN-C-92; modified by drilling hole in shaft and inserting pin as pointer per CCI Dwg no. 326-R-249; p/o Z101	Z101 tuning
C104	N16-C019143-7839	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 0.22 $\mu\mu$f $\pm$20%; 500 wv DC; variable temp coef; ceramic insulated body; body dim 0.160" $\pm$0.010" dia x 0.330" lg; 2 axial wire terminals mtd; mfr CSA, Type GA	Z101-Z102 top coupling
C105	For replacement use N16-C031269-9556	CAPACITOR, FIXED, MICA DIELECTRIC: 1200 $\mu\mu$f $\pm$10%; 500 wv DC; Type CM30B122K, per Spec MIL-C-5A; use CM30E122J	Z101-Z102 common bottom coupling
C106	N16-C019143-3852	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 20,000 $\mu\mu$f +80% —20%; 600 wv DC; variable temp coef; durez phenolic case vacuum waxed jacket; case dim 0.750" dia x 0.120-0.321" thick; 2 radial wire leads 1 1/2" lg min; terminal mtd; mfr CBJS, Type B Discap	Z101-Z102, Band II, parallel bottom coupling
C107	N16-C019140-9551	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 10,000 $\mu\mu$f +80% —20%; 600 wv DC; variable temp coef; durez phenolic case, vacuum waxed jacket; case style Ref Dwg CCI 130-021; case dim 0.610" to 0.640" dia x 0.056" to 0.156" thick; 2 radial wire leads 1 1/2" lg min; terminal mtd; mfr CBJS, Type B Discap	AGC bypass
C108		Same as C101	Z102, Band II, series padder

TABLE 8-2. TABLE OF REPLACEABLE PARTS

REFERENCE DESIGNATION	STOCK NUMBERS STANDARD NAVY	NAME AND DESCRIPTION	LOCATING FUNCTIONS
C109	N16-C027366-1201	CAPACITOR, FIXED, MICA DIELECTRIC: 39 μμf ±5%; 500 wv DC; Type CM20C390J, per Spec MIL-C-5A	Z102, Band III, series padder
C110		Same as C103	Z102 Tuning
C111		Same as C106	V101 cathode bypass
C112		Same as C107	V101 screen bypass
C113		Same as C105	Z103-Z104 common bottom coupling
C114	N16-C018659-8953	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 1,000 μμf ±20%; 600 wv DC; variable temp coef; over-all dim 1 1/8" lg x 5/16" across flats; ceramic case; 2 rigid wire axial hooked end terminals 1/4" lg; feedthru mtg with mtg bushing no. 12-28 thd x 9/32" lg, cadmium plated brass mtg nut; mfr CBN, Type FT-1000 Hi Kaps	Oscillator test
C115		Same as C101	Z103, Band II, series padder
C116		Same as C109	Z103, Band III, series padder
C117		Same as C103	Z103 tuning
C118	For replacement use SNSN N16-C033617-4758	CAPACITOR, FIXED, MICA DIELECTRIC: 10,000 μμf ±10%; 300 wv DC; per Spec MIL-C-5A, Type CM35C103K, p/o Z102; use CM35E103J	Z101-Z102, Band I, parallel bottom coupling
C119		Same as C104	Z103-Z104 top coupling
C120		Same as C101	Z104, Band II, series padder
C121	N16-C027471-5801	CAPACITOR, FIXED, MICA DIELECTRIC: 43 μμf ±5%; 500 wv DC; per Spec MIL-C-5A, Type CM20C430J, p/o Z104	Z104, Band III, series padder
C122		Same as C103	Z104 tuning
C123	N16-C027577-1401	CAPACITOR, FIXED, MICA DIELECTRIC: 47 μμf ±5%; 500 wv DC; Type CM20C470J, per Spec MIL-C-5A	V102 grid
C124	N16-C015528-5428	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 3 μμf ±0.25 μμf; 500 wv DC; Type CC20CJ030C; per Spec MIL-C-20A	V102 plate coupling
C125		Same as C123	V102 plate
C126		Same as C107	B+ bypass
C127	N16-C025513-6245	CAPACITOR, FIXED, MICA DIELECTRIC: 7 μμf ±0.5 μμf; 500 wv DC; temp coef —100 to +100 parts/million/°C; molded case, dim 51/64" lg max by 13/32 wide max by 7/32" thick max; 2 axial wire leads, 1 1/8" lg min; terminal mtd; per Spec MIL-C-5A, p/o Z101	Z101 padder
C128		Same as C107	V103 cathode
C129		Same as C107	V103 screen bypass
C130		Same as C107	V103 plate bypass
C131		Same as C101	T101 padder
C132		Same as C101	T101 padder

C133	N16-C015368-5828	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 1.0 $\mu\mu$f $\pm$0.25 $\mu\mu$f; 500 wv DC; Type CC20CK010C, per Spec JAN-C-20A	T101-T102 coupling
C134		Same as C101	T102 padder
C135		Same as C101	T102 padder
C136		Same as C107	V201 grid return bypass
C137	N16-C028553-1201	CAPACITOR, FIXED, MICA DIELECTRIC: 100 $\mu\mu$f $\pm$5%; 500 wv DC; Type CM20C101J, per Spec MIL-C-5A	V104 grid
C138	N16-C028210-2001	CAPACITOR, FIXED, MICA DIELECTRIC: 100 $\mu\mu$f $\pm$5%; 500 wv DC; Type CM20C820J, per Spec MIL-C-5A	V104 blocking
C139		Same as C137	V104 plate
C140		Same as C107	V104 B+ bypass
C141		Same as C107	V102 screen bypass
C142	N16-C015432-5828	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 2.0 $\mu\mu$f $\pm$0.25 $\mu\mu$f; 500 wv DC; Type CC20CK020C, per Spec JAN-C-20A	2nd mixer injection
C143		Same as C107	V102 filament bypass
C144		Same as C106	V104 filament bypass
C145	For replacement use SNSN N16-C026938-8321	CAPACITOR, FIXED, MICA DIELECTRIC: 25 $\mu\mu$f $\pm$5%; 500 wv DC; temp coef —100 to +100 parts/million/°C; molded case, dim 51/64" lg max by 15/32" wide max by 7/32" thick max; 2 axial wire leads 1 1/8" lg min; terminal mtd; per Spec MIL-C-5A	Crystal Padder
C146		Same as C118	Z103-Z104, Band I, parallel bot-
C147		Same as C106	Z103-Z104, Band II, parallel bottom coupling
C148	N16-C026025-8276	CAPACITOR, FIXED, MICA DIELECTRIC: 10 $\mu\mu$f $\pm$10%; 500 wv DC; Type CM20B100K, per Spec MIL-C-5A	V103 grid coupling
C201	N16-C029713-6806	CAPACITOR, FIXED, MICA DIELECTRIC: 330 $\mu\mu$f $\pm$5%; 500 wv DC; Type CM20D331J, per Spec MIL-C-5A; p/o T201	T201 padder
C202		Same as C201; p/o T201	T201 padder
C203		Same as C201; p/o T202	T202 padder
C204		Same as C201; p/o T202	T202 padder
C205		Same as C201; p/o T203	T203 padder
C206		Same as C201; p/o T203	T203 padder
C207		Same as C201; p/o T204	T204 padder
C208		Same as C201; p/o T204	T204 padder
C209		Same as C107	V201 screen bypass
C210	For replacement use SNSN N16-C015949-1994	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 12 $\mu\mu$f $\pm$5%; 500 wv DC; Type CC20PJ120J, per Spec JAN-C-20A; use CC20PH120G	T201-T202 coupling

TABLE 8-2. TABLE OF REPLACEABLE PARTS

REFERENCE DESIGNATION	STOCK NUMBERS STANDARD NAVY	NAME AND DESCRIPTION	LOCATING FUNCTIONS
C211		Same as C107	V202 grid return bypass
C212		Same as C107	V202 screen bypass
C213		Same as C107	V202 plate return bypass
C214		Same as C107	V203 grid return bypass
C215		Same as C107	V203 screen bypass
C216		Same as C106	V203 plate return bypass
C217	For replacement use SNSN N16-C015560-4628	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 4 $\mu\mu$f $\pm$0.25 $\mu\mu$f; 500 wv DC; Type CC20CK040C, per Spec JAN-C-20A	BFO injection
C218		Same as C137	Detector load bypass
C219	N16-C027999-1801	CAPACITOR, FIXED, MICA DIELECTRIC: 68 $\mu\mu$f $\pm$5%; 500 wv DC; Type CM20C680J, per Spec MIL-C-5A	V205 RF bypass
C220		Same as C107	V205 time constant
C221		Same as C106	V204 grid
C222		Same as C106	V204 cathode bypass
C223		Same as C106	V204 cathode bypass
C224	N16-C018661-1302	CAPACITOR, FIXED, CERAMIC DIELECTRIC: 1,000 $\mu\mu$f +100% —0; 600 wv DC; variable temp coef; durez phenolic case, vacuum waxed jacket; case style Ref Rwg CCI 130-019; case dim 0.230-0.260" dia x 0.056-0.156" thick; 2 radial wire leads 1 1/2" lg min; terminal mtd; mfr CBJS, Type B Discap	V206 grid coupling
C225		Same as C107	AGC bias supply bypass
C226		Same as C107	V206 squelch bypass
C227		Same as C106	V206 plate coupling
C228		Same as C107	AGC bypass
C229		Same as C107; p/o T205	BFO control bypass
C230		Same as C123	V207 coupling
C231		Same as C107	V207 plate bypass
C232		Same as C107	BFO control B+ bypass
C233		Same as C224	BFO grid leak
C234	N16-C029608-2206	CAPACITOR, FIXED, MICA DIELECTRIC: 270 $\mu\mu$f $\pm$5%; 500 wv DC; Type CM20D271J, per Spec MIL-C-5A; p/o T205	T205 padder
C235		Same as C107	V208 cathode bypass
C236		Same as C107	V208 screen bypass
C237		Same as C219	Detector-RF filter

C301		Same as C106	V303 input coupling
C302		Same as C106	V303 output coupling
C303	N16-C019639-7726	CAPACITOR, FIXED, ELECTROLYTIC: bathtub class; 15 μf; 200 wv DC; Type CE63C150K, per Spec JAN-C-62	Bias supply output
C304		Same as C303	Bias supply input
C305(A) (B) (C)	N16-C022489-5051	CAPACITOR, FIXED, ELECTROLYTIC: plug-in class; 3 sections; 10/10/10 μf; 450 wv DC; Type CE53F100R, per Spec JAN-C-62; used with XC301	B+ filter
C306(A) (B) (C)	For replacement use SNSN N16-C022799-4015	CAPACITOR, FIXED, ELECTROLYTIC: plug-in class; 3 sections; 60/60/60 μf; 150 wv DC; Type CE53B600J, per Spec JAN-C-62; used with XC302	T302 isolation
C307		Same as C137	V301 audio shaping
C308		Same as C224	V302 grid coupling
C309	For replacement use SNSN N16-C032641-6338	CAPACITOR, FIXED, MICA DIELECTRIC: 4700 μμf ±10%; 500 wv DC; Type CM35B472K, per Spec MIL-C-5A	V302 plate, screen coupling
C310	For replacement use SNSN N16-C030109-3806	CAPACITOR, FIXED, MICA DIELECTRIC: 470 μμf ±10%; 500 wv DC; Type CM20B471K, per Spec MIL-C-5A	Audio shaping
C401		Same as C114	Phones RF filter
C402		Same as C107	Phones RF filter
C501		Same as C224	RF filter capacitor in the AC line
C502		Same as C224	RF filter capacitor in the AC line
C503		Same as C107	RF filter capacitor in the AC line
C504		Same as C107	RF filter capacitor in the AC line
C505		Same as C114	RF filter capacitor in the AC line
C506		Same as C114	RF filter capacitor in the AC line
C507		Same as C107	RF filter capacitor in the Audio line
C508		Same as C107	RF filter capacitor in the Audio line
C509		Same as C114	RF filter capacitor in the Audio line
C510		Same as C114	RF filter capacitor in the Audio line

TABLE 8-2. TABLE OF REPLACEABLE PARTS

REFERENCE DESIGNATION	STOCK NUMBERS STANDARD NAVY	NAME AND DESCRIPTION	LOCATING FUNCTIONS
C511		Same as C303	DC blocking capacitor in the Audio line
C512		Same as C303	DC blocking capacitor in the Audio line
CR301	N17-R051504-1001	RECTIFIER, METALLIC: selenium; single phase voltage doubler, style no. 3, Ref Dwg Group 23; used as one half of a full wave rectifier system; max input 320 v rms; max current output 75 ma; capacitive load; salt spray resistant; single stack, center cooled with protective end plates; over-all dim 1 5/8" lg x 1" wide x 1" high, excluding terminals and mtg facilities; mtd by one no. 8-32 threaded stud running axially through stack; 3 terminals, solder lug type, located each end of stack and center; mfr CBGB, Type 78D	High voltage rectifier
CR302		Same as CR301	High voltage rectifier
CR303	N17-R051401-8474	RECTIFIER, METALLIC: selenium; single phase half wave, Style no. 5; Ref Dwg Group 23, max input 130 v rms; max current output 50 ma DC; capacitive load; salt spray resistant; molded phenolic case, dim 11/16" lg x 9/16" wide x 13/16" high, excluding terminals and mtg facilities; mtd by one no. 6-32 threaded stud centrally located on bottom; 2 terminals, solder lug type, located on top; mfr CBGB Model 50	Bias supply rectifier
E101	N16-S034557-8351	SHIELD, ELECTRON TUBE: Type TS102U02, per Spec JAN-S-28A; used with V101	V101 tube shield
E102		Same as E101; used with V102	V102 tube shield
E103		SHIELD, ELECTRON TUBE: Type TS102U01, per Spec JAN-S-28A; used with V205	V103 tube shield
E104		Same as E101; used with V104	V104 tube shield
E105	Low failure Item; if required, requisition from ESO referencing Nav-Ships 900,180A	CONTACT, ELECTRICAL: RF inter-chassis connector; consists of conducting spring and mtg board; conducting spring beryllium copper, silver plated, 1 3/16" lg x 5/16" wide x 0.010" thick; mtg board silicone glass base bakelite, 1" lg x 7/16" wide x 1/16" thick; over-all contact dim 1" lg x 7/8" high x 3/8" thick; spring contact drilled at one end to provide solder terminal; contact mtd by two no. 30 holes, 3/4" C to C; mfr CCI per Dwg Nos. 327-C-221X and 327-C-222; used with E209	Inter-chassis IF connector
E106(A) (B) (C) (D)	For Reference Only	SWITCH DECK: 3 pole; 3 position; phenolic section insulation; coin silver contacts, 3 moving and 12 fixed; Ref Dwg Group 8, over-all dim 1 5/16" wide x 1 7/16" high x 1/16" thick, excluding terminals; 2 mtg holes 5/32" dia on 1 3/16" mtg centers; mfr CBN, Part no. PS026-047 E106(A), p/o Z101; used with S101 E106(B), p/o Z102; used with S101 E106(C), p/o Z103; used with S101 E106(D), p/o Z104; used with S101	Band switch decks
E201		Same as E101; used with V201	V201 tube shield
E202		Same as E101; used with V202	V202 tube shield
E203		Same as E101; used with V203	V203 tube shield

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E204		Same as E101; used with V204	V204 tube shield
E205		Same as E103; used with V205	V205 tube shield
E206	N16-S034576-6513	SHIELD, ELECTRON TUBE: Type TS103U02, per Spec JAN-S-28A; used with V102	V206 tube shield
E207		Same as E206; used with V207	V207 tube shield
E208		Same as E101; used with V208	V208 tube shield
E209		Same as E105; used with E105	Inter-chassis IF connector
E210(A) (B)	For reference only	SWITCH DECK: 2 pole; 2 position; phenolic section insulation; coin silver contacts, 2 moving and 6 fixed; Ref Dwg Group 8, over-all dim 1 5/16" wide x 1 7/16" high x 1/16" thick, excluding terminals; 2 mtg holes 5/32" dia on 1 3/16" mtg centers; mfr CBN, Part no. PS026-046; p/o S201	Selectivity switch decks
E301		Same as E101; used with V301	V301 tube shield
E302	N16-S034593-6631	SHIELD, ELECTRON TUBE: for use with RETMA tube envelope style T-5-1/2(6-5); straight cylinder shape with flared end, open top, vented; brass, 2 1/4 " lg., 1.093" dia; mounts on shock shield base, contains one (1) spring; mfr ELCO Corp, Code 91662, Part no. 149V-P25	V302 tube shield
E303			V303 tube shield
E304(A)		Same as E206; used with V303	Reception switch decks
(B)		Same as E106; p/o S301	
E401	Low failure item; if required, requisition from ESO referencing NavShips 900,180A	CLUTCH ASSEMBLY: consists of slotted clutch plate, mtd on RECEPTION switch control shaft on Front Panel, positioned to engage shaft with cross-pin of S301, located on Audio/Power Supply chassis; shaft is grooved in 2 places for "engaged" (in) and "disengaged" (out) positions and held in these positions by 2 ball bearings, spring retained; mfr CCI, Dwg no. 326-R-232X	Reception switch clutch
E402	Low failure item; if required, requisition from ESO ..referencing.. NavShips 900-180A	Same as E401, except mtd on SELECTIVITY switch control shaft on Front Panel and used with S201 on IF chassis	Selectivity switch clutch
E403	For reference only	SWITCH DECK: 3 pole, 2 position; phenolic section insulation; coin silver contacts, 3 moving and 9 fixed; Ref Dwg Group 8, over-all dim 1 5/16" wide x 1 7/16" high x 1/16" thick, excluding terminals; 2 mtg holes 5/32" dia on 1 3/16" mtg centers; mfr CBN, Part no. PS026-053; p/o S403	Reception switch deck
E501	N17-S250051-0153	SHELL, ELECTRICAL CONNECTOR: Type UG-177/U, per Spec MIL-C-71A; used with J501	Antenna receptacle shield
E601	Procured on demand by nearest Naval Shore Supply Activity	SHELL, ELECTRICAL CONNECTOR: case of die cast aluminum with tin plate and clear lacquer finish; rectangular; over-all dim 2 43/64" lg x 2 11/16" wide x 1 11/16" high; mtd by 4 holes, no. 27 drill on 2.188" x 1" mtg centers; mfr, CED, Type DPB-34; p/o W601	Test cable connector shell
E602	Procured on demand by nearest Naval Shore Supply Activity	SHELL, ELECTRICAL CONNECTOR: case of die cast aluminum with tin plate and clear lacquer finish; rectangular; over-all dim 2" lg x 2 11/16" wide x 1 11/16" high; mtd by 4 holes, no. 27 drill on 2.188" x 1" mtg centers; mfr, CED, Type DPB-33; p/o W601	Test cable connector shell
F301	G5920-280-4465	FUSE, CARTRIDGE: rated at 1 amp, 250 v max; time lag type; 0-1 hour blowing time for 135% overload, 6 seconds min for 300% overload; mfr CLF; Type F02G1R00B, per Spec MIL-F-15160A; used with XF301	Power line fuse
F302		Same as F301; used with XF302	Power line fuse
F303		Same as F301	Spare power line fuse

TABLE 8-2. TABLE OF REPLACEABLE PARTS

REFERENCE DESIGNATION	STOCK NUMBERS STANDARD NAVY	NAME AND DESCRIPTION	LOCATING FUNCTIONS
FL301	N16-F032120-1751	FILTER, BAND PASS: operating frequency 1000 cycles; input impedance 75,000 ohms; output impedance 220,000 ohms; max level 0 dbm; band width 550 max to 350 min at —6 db, 900 max to 600 min at —40 db; —40 db min outside passband; hermetically sealed in upright steel case, finish gray lacquer; over-all dim 2 5/16 " lg x 2 1/16" wide x 3 1/8" high, excluding terminals and mtg studs; mtd by four studs, no. 6-32 thread x 1/4" lg on 1 7/16" x 1 11/16" mtg centers; three post terminals located on bottom and marked IN, OUT and G; mfr CUD, Part no. D 6410	1000 cycle audio fliter
I201	G6240-179-1813	LAMP, NEGATIVE-GLOW: neon; mfr CG, Type NE16; per Spec MIL-L-15098, Type VG-8; used with XI201	BFO voltage regulator
I202		Same as I201; used with XI202	B+ voltage regulator
I401	G6240-223-0100	LAMP, NEGATIVE-GLOW: neon; parallel post electrodes; 1/4 watt; operating voltage 105-125 v AC and DC; starting voltage: 65 v 60 cycle AC, 95 v DC; 3000 hours rated life; miniature bayonet base; clear tubular bulb; 13/32" bulb dia max x 1 3/16" over-all height max; mfr CG, Type NE51; used with XI401	Pilot light
J101	N17-C073615-4692	CONNECTOR RECEPTACLE: 20 round male contacts, four no. 16 and sixteen no. 20, brass, gold plated; rated at 500 v rms; polarized; with barriers; straight; rectangular; over-all dim 3/8" lg x 3/4" wide x 1 15/16" high, excluding terminals; molded, mica-filled phenolic; mtd by two holes for no. 4 screws on 1.62" mtg centers; mfr CPH Type 26-806; used with J401	RF chassis-front panel connectors
J102	For replacement use SNSN N17-C073180-2878	CONNECTOR RECEPTACLE: 1 round female contact; 50 ohms nominal impedance; Type UG-290/U, per Spec MIL-C-3608; used with P301; use UG-290A/U	Inter-chassis antenna cable connector
J201		Same as J101; used with J402	IF chassis-front panel connector
J301		Same as J101; used with J403	Audio/Power supply-front panel connector
J302	N17-C073569-8951	CONNECTOR, RECEPTACLE: 10 round male contacts, six 15 amp, two 30 amp, two 10 amp coaxial; polarized, straight; rectangular; over-all dim 1 7/64" lg, excluding protruding contacts x 2 11/16" wide x 1 11/16" high; case aluminum alloy with tin plate and clear lacquer finish; molded melamine insert; mtd by 4 holes, 0.144" dia on 1" x 2 3/16" mtg centers; mfr CED, Type DPB-A10C2-34P; used with J504	Audio/Power supply-rear compartment connector
J401	N17-C073323-3220	CONNECTOR, RECEPTACLE: 20 round female contacts, four no. 16 and sixteen no. 20, beryllium copper, gold plated; rated at 500 v rms; polarized; with barriers; straight; rectangular over-all dim 3/8" lg x 3/4" wide x 1 15/16" high, excluding terminals; molded mica filled phenolic; mtd by two holes, for no. 4 screws on 1.62" mtd centers; mfr CPH, Type 26-807; used with J101	Front panel-RF chassis connector
J402		Same as J401; used with J201	Front panel-IF chassis connector
J403		Same as J401; used with J301	Front panel-Audio/Power supply chassis connector
J404	N17-J039248-4418	JACK, TELEPHONE: for 2-conductor plug; Type JJ-034, per Spec JAN-J-641	Phones jack

J501	N17-C073108-5906	CONNECTOR, RECEPTACLE: 1 round male contact; 50 ohms nominal impedance; Type UG-58A/U, per Spec MIL-C-71A; used with P501	Antenna jack
J502	N17-C072595-1800	CONNECTOR, RECEPTACLE: 2 round male pin contacts, no. 16-20 amp; polarized; Type AN3102A-10SL-4P; per Spec MIL-C-5015; used with P502	AC power jack
J503	N17-C072602-9330	CONNECTOR, RECEPTACLE: 3 round male pin contacts, no. 16-20 amp; polarized; Type AN3102A-10SL-3P, per Spec MIL-C-5015; used with P503	Remote jack
J504	N17-C073285-6012	CONNECTOR, RECEPTACLE: 10 round female contacts, 6-15 amp, 2-30 amp and 2-10 amp coaxial; polarized; rectangular; straight; over-all dim 63/64" lg x 2 11/16" wide x 1 11/16" high, excluding protruding contacts; case of aluminum alloy with tin plate and clear lacquer coating; molded melamine insert; mtd by 4 holes, 0.144" dia on 1" x 2 3/16" mtg centers; mfr CED, Type DPB-A10C2-33S; used with J302	Rear compartment-Audio/Power supply connector
J505		Same as J503; used with P504	Audio jack
L101	For reference only	COIL, RADIO FREQUENCY; Band I p/o Z101	Antenna coil
L102	For reference only	COIL, RADIO FREQUENCY; Band II p/o Z101	Antenna coil
L103	For reference only	COIL, RADIO FREQUENCY; Band III p/o Z101	Antenna coil
L104	For reference only	COIL, RADIO FREQUENCY; Band I p/o Z102	V101 RF grid coil
L105	For reference only	COIL, RADIO FREQUENCY; Band II p/o Z102	V101 RF grid coil
L106	For reference only	COIL, RADIO FREQUENCY; Band III p/o Z102	V101 RF grid coil
L107	For reference only	COIL, RADIO FREQUENCY; Band I p/o Z103	V101 RF plate coil
L108	For reference only	COIL, RADIO FREQUENCY; Band II p/o Z103	V101 RF plate coil
L109	For reference only	COIL, RADIO FREQUENCY; Band III p/o Z103	V101 RF plate coil
L110	For reference only	COIL, RADIO FREQUENCY; Band I p/o Z104	V102 RF grid coil
L111	For reference only	COIL, RADIO FREQUENCY; Band II p/o Z104	V102 RF grid coil
L112	For reference only	COIL, RADIO FREQUENCY; Band III p/o Z104	V102 RF grid coil
L113	For reference only	COIL, TRANSFORMER; p/o T101	1st 2020 Kc transformer primary
L114	For reference only	COIL, TRANSFORMER; p/o T101	1st 2020 Kc transformer secondary
L115	For reference only	COIL, TRANSFORMER; p/o T102	2nd 2020 Kc transformer primary
L116	For reference only	COIL, TRANSFORMER; p/o T102	2nd 2020 Kc transformer secondary
L201	For reference only	COIL, RADIO FREQUENCY; p/o T205	BFO control
L202	For reference only	COIL, TRANSFORMER; p/o T201	V201 plate transformer primary
L203	For reference only	COIL, TRANSFORMER; p/o T201	V201 plate transformer secondary
L204	For reference only	COIL, TRANSFORMER; p/o T202	V202 grid transformer primary

TABLE 8-2. TABLE OF REPLACEABLE PARTS

REFERENCE DESIGNATION	STOCK NUMBERS STANDARD NAVY	NAME AND DESCRIPTION	LOCATING FUNCTIONS
L205	For reference only	COIL, TRANSFORMER; p/o T202	V202 grid transformer secondary
L206	For reference only	COIL, TRANSFORMER; p/o T203	V203 grid transformer primary
L207	For reference only	COIL, TRANSFORMER; p/o T203	V203 grid transformer secondary
L208	For reference only	COIL, TRANSFORMER; p/o T204	V204 diode transformer primary
L209	For reference only	COIL, TRANSFORMER; p/o T204	V204 diode transformer secondary
L301	N16-R029236-8021	REACTOR: filter choke; one section; inductance 10 henries +50% —20%; current rating 100 ma, DC; direct current resistance 150 ohms ±15%; insulation test voltage 1500 v rms; peak working voltage 535 v; steel, enclosed case, electro tin plate finish; over-all dim Ref Dwg Group 12, 3 1/4″ lg x 2 5/8″ wide x 2 7/8″ high; mtd by 4 weldbolts, no. 8-32 thread x 3/8″ lg on 2 1/2″ x 1 7/8″ mtg centers; 2 post terminals, located on bottom and numbered 1 and 2; mfr CADF, Type 88C2; CCI Dwg no. 327-C-302	B+ filter choke
L401	N16-C076791-9343	COIL, RADIO FREQUENCY: choke; inductance 430 μh ±10%; direct current resistance 7.6 ohms; current rating 25 ma; over-all dim 3/8″ dia x 5/16″ lg, excluding terminals; 2 wire terminals, located axially at each end; terminal mtd; powdered iron coil form; mfr Wilco Corp, 546 Drover St, Indianapolis, Ind; Part no. 3430-15	Phones RF filter choke
L501	N16-C074484-9020	CHOKE, RADIO FREQUENCY: attenuates frequencies between 2-40 Mc; cylindrical shape; over-all dim 13/16″ dia x 1 9/16″ lg, excluding terminals; 2 wire terminals, located at each end; mtd by no. 5-40x2″ machine screw through center of iron core slugs; powdered iron core; not adjustable; mfr CCI, Dwg no. 327-R-E-309	RF filter choke in the AC line
L502		Same as L501	RF filter choke in the AC line
L503	N16-C072745-1875	CHOKE, RADIO FREQUENCY: attenuates frequencies between 40-200 Mc; cylindrical shape; over-all dim 1/4″ dia x 1″ lg, excluding terminals; 2 wire terminals, located axially at each end; terminal mounted; bakelite coil form; mfr CCI, Dwg no. 327-R-E-308	RF filter choke in the AC line
L504		Same as L503	AC line filter choke
L505		Same as L501	Audio line filter choke
L506		Same as L501	Audio line filter choke
L507		Same as L503	Audio line filter choke
L508		Same as L503	Audio line filter choke
P301	For replacement use SNSN N17-C071408-9255	CONNECTOR, PLUG: 1 round male contact; nominal impedance 50 ohms; Type UG-88/U, per Spec MIL-C-3608; used with J102; use UG-88C/U	Inter-chassis antenna cable connector
P501	For replacement use SNSN N17-C071417-9699	CONNECTOR, PLUG: 1 round male contact; nominal impedance 50 ohms; Type UG-21B/U, per Spec MIL-C-71A; used with J501	Antenna plug

P502	N17-C070319-1800	CONNECTOR, PLUG: 2 round female contacts, no. 16, 20 amp; polarized; Type AN3106A-10SL-4S, per Spec MIL-C-5015; used with J502	AC power plug
P503	N17-C070326-9330	CONNECTOR, PLUG: 3 round female contacts, no. 16, 20 amp; polarized; Type AN3106A-10SL-3S, per Spec MIL-C-5015; used with J503	Remote plug
P504		Same as P503; used with J505	Audio plug
P601		Same as J302; p/o W601	Test cable connector
P602		Same as J504; p/o W601	Test cable connector
R101	For replacement use SNSN N16-R050632-0416	RESISTOR, FIXED, COMPOSITION: 100,000 ohms ±10%; 1/2 watt; Type RC20BF104K, per Spec MIL-R-11; use RC20GF104J	V101 AGC isolation
R102	For replacement use SNSN N16-R049498-0438	RESISTOR, FIXED, COMPOSITION: 68 ohms ±10%; 1/2 watt; Type RC20BF680K, per Spec MIL-R-11; use RC20GF680J	V101 cathode
R103	For replacement use SNSN N16-R050389-0131	RESISTOR, FIXED, COMPOSITION: 27,000 ohms ±10%; 1/2 watt; Type RC20BF273K, per Spec MIL-R-11; use RC20GF273J	V101 screen
R104	For replacement use SNSN N16-R050011-0438	RESISTOR, FIXED, COMPOSITION: 2,200 ohms ±10%; 1/2 watt; Type RC20BF222K, per Spec MIL-R-11; use RC20GF222J	V101 plate dropping
R105	For replacement use SNSN N16-R049768-0438	RESISTOR, FIXED, COMPOSITION: 470 ohms ±10%; 1/2 watt; Type RC20BF471K, per Spec MIL-R-11; use RC20GF471J	V101, Band II, cathode series
R106	For replacement use SNSN N16-R050479-0435	RESISTOR, FIXED, COMPOSITION: 47,000 ohms ±10%; 1/2 watt; Type RC20BF473K, per Spec MIL-R-11; use RC20GF473J	V102 grid bias
R107	For replacement use SNSN N16-R050371-0433	RESISTOR, FIXED, COMPOSITION: 22,000 ohms ±10%; 1/2 watt; Type RC20BF223K, per Spec MIL-R-11; use RC20GF223J	V102 plate
R108	For replacement use SNSN N16-R050065-0438	RESISTOR, FIXED, COMPOSITION: 3300 ohms ±10%; 1/2 watt; Type RC20BF332K, per Spec MIL-R-11; use RC20GF332J	V103 cathode
R109	For replacement use SNSN N16-R050974-0438	RESISTOR, FIXED, COMPOSITION: 1 meg ±10%; 1/2 watt; Type RC20BF-105K, per Spec MIL-R-11; use RC20GF105J	V102 oscillator metering
R110		Same as R104	V101 plate dropping
R111		Same as R101	V201 AGC isolation
R112		Same as R106	V104 grid bias
R113	For replacement use SNSN N16-R050713-0380	RESISTOR, FIXED, COMPOSITION: 220,000 ohms ±10%; 1/2 watt; Type RC20BF224K, per Spec MIL-R-11; use RC20GF224J	V104 plate dropping
R114	For replacement use SNSN N16-R088009-4010 as indicated in description	RESISTOR, VARIABLE, COMPOSITION: 1 section; 100,000 ohms ±10%; 2 watts; Std A taper; Type RV4ATSA104A, per Spec JAN-R-94; modfied by drilling hole in shaft and inserting pin as pointer per CCI Dwg no. 326-R-260	Oscillator activity control
R115		Same as R106	V102 B+ dropping
R116	For replacement use SNSN N16-R050281-0438	RESISTOR, FIXED, COMPOSITION: 10,000 ohms ±10%; 1/2 watt; Type RC20BF103K, per Spec MIL-R-11; use RC20GF103J	
R117	For replacement use SNSN N16-R051019-0440	RESISTOR, FIXED, COMPOSITION: 1.5 meg ±10%; 1/2 watt; Type RC-20BF155K, per Spec MIL-R-11; use RC20GF155J	V103 grid bias

TABLE 8-2. TABLE OF REPLACEABLE PARTS

REFERENCE DESIGNATION	STOCK NUMBERS STANDARD NAVY	NAME AND DESCRIPTION	LOCATING FUNCTIONS
R118	For replacement use SNSN N16-R050092-0438	RESISTOR, FIXED, COMPOSITION: 3,900 ohms ±10%; 1/2 watt; Type RC20BF392K, per Spec MIL-R-11	V101, Band I, cathode series
R119	For replacement use SNSN N16-R050857-0438	RESISTOR, FIXED, COMPOSITION: 560,000 ohms ±10%; 1/2 watt; Type RC20BF564K, per Spec MIL-R-11	V103 screen dropping
R201	N16-R085C10-4433	RESISTOR, THERMAL: Nominal resistance at 25°C (77°F) is 470 ohms; 75 ma max operating current, AC or DC operation; overall dim 5/8 in. lg, 7/32 in, dia; radial wire terminals, lead length 1 1/2 in.; mfr CCO, type no. 763F	V201 cathode
R202	For replacement use SNSN N16-R050371-0711	RESISTOR, FIXED, COMPOSITION: 22,000 ohms ±10%; 1 watt; Type RC30BF223K, per Spec MIL-R-11; use RC32GF223J	V201 plate dropping resistor
R203	For replacement use SNSN N16-R049579-0131	RESISTOR, FIXED, COMPOSITION: 100 ohms ±10%; 1/2 watt; Type RC20BF101K, per Spec MIL-R-11; use RC20GF101J	T202 loading resistor
R204		Same as R101	V202 AGC resistor
R205		Same as R106	V202 screen loading resistor
R206		Same as R106	V202 screen dropping resistor
R207		Same as R104	V202 plate dropping resistor
R208		Same as R105	
R209		Same as R116	V203 screen resistor
R210	N16-R049922-0811	RESISTOR, FIXED, COMPOSITION: 1,000 ohms ±10%; 1/2 watt; Type RC20BF102K, per Spec MIL-R-11	V203 plate dropping resistor
R211	For replacement use SNSN N16-R050677-0380	RESISTOR, FIXED, COMPOSITION: 150,000 ohms ±10%; 1/2 watt; Type RC20BF154K, per Spec MIL-R-11	Detector loading resistor
R212		Same as R101	Detector loading resistor
R213		Same as R107	Detector loading resistor
R214		Same as R109	Noise limiter time constant
R215		Same as R109	Noise limiter cathode load resistor
R216		Same as R113	V204 grid resistor
R217	N16-R087849-4746	RESISTOR, VARIABLE: 1 section; 50,000 ohms ±10%; 2 watts; Std F taper; Type RV4ATSC503E per Spec JAN-R-94	Squelch control
R218		Same as R107	V204 cathode resistor
R219	For replacement use SNSN N16-R050551-0401	RESISTOR, FIXED, COMPOSITION: 68,000 ohms ±5%; 1/2 watt; Type RC20BF683J, per Spec MIL-R-11; use RC20GF683J	AGC bias regulating resistor
R220	For replacement use SNSN N16-R050416-0682	RESISTOR, FIXED, COMPOSITION: 33,000 ohms ±10%; 1 watt; Type RC30BF333K, per Spec MIL-R-11; use RC32GF333J	I202 B+ dropping resistor
R221		Same as R109	V206 grid resistor
R222		Same as R101	V206 plate resistor

R223	For replacement use SNSN N16-R049966-0433	RESISTOR, FIXED, COMPOSITION: 1500 ohms ±10%; 1/2 watt; Type RC20BF152K, per Spec MIL-R-11; use RC20GF152J	V206 cathode resistor
R224	For replacement use SNSN N16-R050128-0438	RESISTOR, FIXED, COMPOSITION: 4,700 ohms ±10%; 1/2 watt; Type RC20BF472K, per Spec MIL-R-11; use RC20GF472J	V206 voltage divider
R225	For replacement use SNSN N16-R050479-0713	RESISTOR, FIXED, COMPOSITION: 47,000 ohms ±10%; 1 watt; Type RC30BF473K, per Spec MIL-R-11; use RC32GF473J	V206 voltage divider
R226		Same as R109	V206 plate resistor
R227		Same as R113	V206 cathode resistor
R228		Same as R107	V206 cathode resistor
R229		Same as R109	V206 grid resistor
R230		Same as R101	V206 grid resistor
R231		Same as R113	AGC bias resistor
R232	For replacement use SNSN N16-R050011-0438	RESISTOR, FIXED, COMPOSITION: 2,000 ohms ±5%; 1/2 watt; Type RC20BF222J, per Spec MIL-R-11; use RC20GF222J	AGC bias resistor
R233		Same as R106	AGC bias regulating resistor
R234		Same as R101	BFO grid leak resistor
R235		Same as R106	BFO plate resistor
R236		Same as R220	I201 B+ dropping resistor
R237		Same as R113	BFO frequency control resistor
R238		Same as R210	V208 cathode resistor
R239	For replacement use SNSN N16-R050758-0377	RESISTOR, FIXED, COMPOSITION: 330,000 ohms ±10%; 1/2 watt; Type RC20BF334K, per Spec MIL-R-11; use RC20GF334J	V208 screen resistor
R240		Same as R101	V208 plate resistor
R241		Same as R101	Detector RF filter
R242		Same as R101	Detector RF filter
R243		Same as R101	V203 grid resistor
R301	N16-R089071-3405	RESISTOR, VARIABLE, COMPOSITION: 2 section; section A (farthest from bushing: 50,000 ohms ±10%; section B (next to bushing): 250,000 ohms ±10%; 2 watts; Std C taper; normal torque; rd slotted shaft 1/4" dia x 3/4" lg; metal enclosed case, dim per Ref Dwg Group 3, 1 1/8" dia x 7/8" deep; 3 solder lug type terminals per section; mtd by bushing 3/8"-32 thd x 3/8" lg; Spec JAN-R-94 used as guide; mfr CTC, Part no. BR7229-P250K-R50K-CTS-437	AF level
R302	For replacement use SNSN N16-R050695-0436	RESISTOR, FIXED, COMPOSITION: 180,000 ohms ±10%; 1/2 watt; Type RC20BF184K, per Spec MIL-R-11; use RC20GF184J	V303 B+ dropping resistor
R303		Same as R101	Audio compensation resistor
R304		Same as R107	Bias dropping resistor
R305		Same as R219	Bias dropping resistor

TABLE 8-2. TABLE OF REPLACEABLE PARTS

REFERENCE DESIGNATION	STOCK NUMBERS STANDARD NAVY	NAME AND DESCRIPTION	LOCATING FUNCTIONS
R306	For replacement use SNSN N16-R050164-0761	RESISTOR, FIXED, COMPOSITION: 5600 ohms ±10%; 1 watt; Type RC-30GF562K, per Spec MIL-R-11; use RC32GF562J	Bias filter resistor
R307	For replacement use SNSN N16-R066251-3296	RESISTOR, FIXED, WIRE WOUND: power type; 5,000 ohms; ±5%; 15 watts; Type RW20G502, per Spec MIL-R-26B	B+ filter resistor
R308		Same as R113	V303 cathode resistor
R309		Same as R113	V303 cathode resistor
R310	For replacement use SNSN N16-R050821-0276	RESISTOR, FIXED, COMPOSITION: 470,000 ohms ±10%; 1/2 watt; Type RC20BF474K, per Spec MIL-R-11; use RC20GF474J	V303 plate resistor
R311		Same as R224	V301 cathode resistor
R312		Same as R113	V301 plate resistor
R313	For replacement use SNSN N16-R051064-0435	RESISTOR, FIXED, COMPOSITION: 2.2 megohms ±10%; 1/2 watt; Type RC20BF225K, per Spec MIL-R-11; use RC20GF225J	V302 degeneration resistor
R314		Same as R101	V302 grid resistor
R315		Same as R101	Audio compensating resistor
R316		Same as R101	Audio compensating resistor
R401	For replacement use SNSN N16-R050443-0438	RESISTOR, FIXED, COMPOSITION: 39,000 ohms ±10%; 1/2 watt; Type RC20BF393K, per Spec MIL-R-11; use RC20GF393J	Bias dropping resistor
R402	For replacement use SNSN N16-R050038-0438	RESISTOR, FIXED, COMPOSITION: 2,700 ohms ±10%; 1/2 watt; Type RC20BF272K, per Spec MIL-R-11; use RC20GF272J	Bias dropping resistor
R403		Same as R113	B+ dropping resistor for BFO control
R404		Same as R217	Head-telephone control
R405	For replacement use SNSN N16-R087849-4757	RESISTOR, VARIABLE: composition, 1 section 50,000 ohms; 2 watts; Std A taper; Type RV4ATSC503A, per Spec JAN-R-94; use RVATSD503A	RF gain control
R406		Same as R405	BFO control
S101	Low Failure Item: if required, requisition from ESO referencing Nav-Ships 900,180A	SWITCH INDEX: shaft, rear portion 10 1/2" total length: 8 3/4" lam glass cloth bakelite, 1 3/4" steel cad pl, 1/4" dia flatted on opposite sides to 3/16" thickness with positioning slot 3/16" dia x 5/32" wide, located 3/16" from back surface of index plate; front portion: 7/8" lg from front of index plate, shaft 1/4" dia slotted for screwdriver adjustment; mtd by mtg plate 2 holes 0.128" dia on 1 1/4" mtg centers; switch index plate to be 3 position; mfr CBN, per CCI Dwg no. 326-R-215; used with E106 (A), (B), (C), (D)	RF band switch

S201	N17-S065193-5687	SWITCH, ROTARY: 2 sections; 4 pole; 2 position; 4 moving and 12 fixed non-shorting coin silver contacts; phenolic section insulation; over-all dim, Ref Dwg Group 8, 9 3/4" lg x 1 5/16" wide x 1 1/2" high; bracket mtd: front bracket 2 mtg holes 1/8" dia on 1 7/16" mtg centers, rear bracket 2 mtg holes 5/32" dia on 3/4" mtg centers; round shaft 1/4" dia x 7/8" lg from body; pin 0.102" dia located 3/32" from end of shaft for engaging clutch assembly on front panel; mfr CCI, Dwg no. 326-R-228X; includes E210(A), (B); used with E402	Selectivity switch
S202	N17-S070412-4406	SWITCH, TOGGLE: SPST; 40 amps; 125 v; Type ST42A, per Spec JAN-S-23	Noise limiter switch
S301	N17-S064718-5471	SWITCH, ROTARY: 2 sections; 6 pole; 3 position; 6 moving and 24 fixed non-shorting coin silver contacts; phenolic section insulation; over-all dim Ref Dwg Group 8, 1 1/4" lg x 1 5/16" wide x 1 1/2" high; bracket mtd, 2 mtg holes 5/32" dia on 1 7/16" mtg centers; round shaft 1/4" dia x 7/8" lg from body; pin 0.102" dia located 3/32" from end of shaft for engaging clutch assembly on front panel; mfr CCI, Dwg no. 326-R-256X; includes E304(A), (B); used with E401	Reception switch
S401	N17-S072828-2605	SWITCH, TOGGLE: DPST; 30 amps, 125 v; Type ST52K, per Spec JAN-S-23	Power switch
S402	N17-S056611-5507	SWITCH, PUSH: SPST; single "make" type momentary contact; normally open; molded phenolic housing and button; red button; rated 1/2 amp, 115 v AC; non-inductive; overall dim 1 17/32" lg, including terminals and actuating button x 51/64" dia max; single hole mtg; bushing 15/32" dia -32 thread x 3/8" lg with hex mtg nuts; two solder lug terminals; mfr CBDW, Type 4001	Squelch test switch
S403	N17-S061714-4581	SWITCH, ROTARY: 1 section; 3 pole; 2 position; 3 moving and 9 fixed non-shorting coin silver contacts; phenolic section insulation; over-all dim Ref Dwg Group 8, 3/4" lg x 1 5/16" wide x 1 1/2" high; bushing mtd, 3/8" dia x 32 thd x 3/8" lg; round shaft 1/4" dia x 5/16" lg from body; mfr CCI, Dwg no. 326-R-257X; includes E403	Local-remote switch
T101	N17-T068397-8361	TRANSFORMER, INTERMEDIATE FREQUENCY: peak frequency 2020 Kc; input; shielded; over-all dim 1 7/16" square x 3 3/16" high, excluding terminals and tuning screws; phenolic coil form; double adjustable iron core tuning; primary padder capacitor 75$\mu\mu$f, secondary padder capacitor 75 $\mu\mu$f; mtd by two no. 4-40 threaded rods on 1 3/8" mtg centers; four solder lug terminals, located on bottom; mfr CCI, Dwg no. 331-R-301; consists of L113, L114, C131, C132	2020 Kc IF input transformer
T102		Same as T101; consists of L115, L116, C134 and C135	
T201	N17-T067468-3747	TRANSFORMER, INTERMEDIATE FREQUENCY: peak frequency 120 Kc: used as input and interstage; shielded; over-all dim 1 7/16" square x 3 1/16" high, excluding terminals and tuning screws; phenolic coil form; double adjustable iron core tuning; 2 position, adjustable selectivity (BROAD-SHARP); primary padder capacitor 330 $\mu\mu$f, secondary padder capacitor 330 $\mu\mu$f; mtd by two no. 4-40 threaded rods on 1 3/8" mtg centers; 6 solder lug terminals, located on bottom; mfr CCI, Dwg no. 326-R-312; consists of L202, L203, C201, C202; used with S201	V201 output, 120 Kc transformer

TABLE 8-2. TABLE OF REPLACEABLE PARTS

REFERENCE DESIGNATION	STOCK NUMBERS STANDARD NAVY	NAME AND DESCRIPTION	LOCATING FUNCTIONS
T202		Same as T201; consists of L204, L205, C203, C204; used with S201	V202 input, 120 Kc transformer
T203		Same as T201; consists of L206, L207, C205, C206; used with S201	V203 input, 120 Kc transformer
T204	N17-T067468-3748	TRANSFORMER, INTERMEDIATE FREQUENCY: peak frequency 120 Kc; output; shielded; over-all dim 1 7/16" square x 3 3/16" high, excluding terminals and tuning screws; phenolic coil form; double adjustable iron core tuning; primary padder capacitor 330 $\mu\mu$f, secondary padder capacitor 330 $\mu\mu$f; mtd by two no. 4-40 threaded rods on 1 3/8" mtg centers; four solder lug terminals, located on bottom; mfr CCI, Dwg no. 326-R-310; consists of L208, L209, C207, C208	V203 output, 120 Kc transformer
T205	N17-T081354-9385	TRANSFORMER, INTERMEDIATE FREQUENCY: peak frequency 120 Kc; beat frequency oscillator; shielded; over-all dim 1 7/16" square x 2" high, excluding terminals and tuning screws; phenolic coil form; adjustable iron core tuning; padder capacitor 330 $\mu\mu$f; fixed capacitors 42 $\mu\mu$f, 0.01 μf; fixed resistor 220,000 ohms, 1/2 watt; mtd by two no. 4-40 threaded rods on 1 3/8" mtg centers; mfr CCI, Dwg no. 326-R-309; consists of L201, C229, C230, C234, R237	V207 BFO transformer
T301	N17-T073688-3591	TRANSFORMER, POWER, STEP-DOWN AND STEP-UP: steel, enclosed case; electro tin plate finish; input voltage 105/115/125 v AC, 60 cycle, single phase; two output windings; no. 1 secondary winding, center-tapped, with output of 450 v-85 ma and a 2nd tap with output of 75 v rms from center tap; no. 2 secondary winding with output of 6.3 v-5 amp; impregnating material "Petrocene A" Socony Vacuum Oil Co.; dim Ref Dwg Group 12, 3 5/8" lg x 3 3/16" wide x 3 1/4" high; 10 post terminals, located on bottom and numbered 1 through 10; mtd by four weldbolts, no. 8-32 thread x 3/8" lg on 2 13/16" x 2 1/2" mtg centers; grounded electrostatic shield; mfr CADF, Type 88P5; CCI Dwg no. 327-C-302	Power transformer
T302	N17-T064535-9171	TRANSFORMER, AUDIO FREQUENCY: plate coupling type; primary impedance 5,000 ohms; secondary impedance: no. 1 winding 300 ohms, center-tapped; no. 2 winding 600 ohms; primary DC rating .045 amps; peak working voltages: primary 122 v, secondary no. 2: 4.25 v, secondary no. 1: 30.0 v; upright steel case, electro tin plated; core material dynamo anneal steel; over-all dim Ref Dwg Group 12, 2 5/16" lg x 2 1/16" wide x 3 1/8" high; 1 1/2 watts max audio operating level; ratio of turns, primary to secondary no. 1: 4.05 to 1; primary to secondary no. 2: 28.33 to 1; frequency response $\pm$3 db from 200-3,000 cycles; 8 post terminals located on bottom and numbered 1 through 8; mtd by four no. 6-32 x 3/8" lg weld-bolts on 1 7/16" x 1 11/16" mtg centers; grounded electrostatic internal shield; mfr CADF, Type 88A10; CCI Dwg no. 327-C-301	Audio output transformer
TB101	Shop manufacture	TERMINAL BOARD: silicone glass base bakelite; 12 terminals, miniature hollow swaged type, silver plated; without barriers; over-all dim 1 13/16" lg x 1 1/4" wide x 13/16" high; including terminals and standoffs; mtd by two dural aluminum clinch standoffs, threaded for no. 6-32 screws, on 5/8" mtg centers; mfr CCI, Dwg nos. 326-R-217, 331-R-602	RF chassis terminal board

TB102	Shop manufacture	TERMINAL BOARD: silicone glass base bakelite; 16 terminals, miniature hollow swaged type, silver plated; without barriers; over-all dim 2 9/16" lg x 1 3/16" wide by 13/16" high; including terminals and standoffs; mtd by two dural aluminum clinch standoffs, threaded for no. 6-32 screws on 1 1/4" mtg centers; mfr CCI, Dwg nos. 331-R-204, 331-R-603	RF chassis terminal board
TB103	Shop manufacture	TERMINAL BOARD: silicone glass base bakelite; 26 terminals, miniature hollow swaged type, silver plated; without barriers; over-all dim 5 7/8" lg x 1" wide x 13/16" high, including terminals and standoffs; mtd by three dural aluminum clinch standoffs, threaded for no. 6-32 screws on 2 3/16" mtg centers; mfr CCI, Dwg nos. 326-R-205, 331-R-604	RF chassis terminal board
TB201	Shop manufacture	TERMINAL BOARD: silicone glass base bakelite; 22 terminals, miniature hollow swaged type, silver plated; without barriers; over-all dim 3 1/2" lg x 1 1/4" wide x 13/16" high, including terminals and standoffs; mtd by two dural aluminum clinch standoffs, threaded for no. 6-32 screws on 2 21/32" mtg centers, mfr CCI, Dwg nos. 326-R-224, 326-R-613	IF chassis terminal board
TB202	Shop manufacture	TERMINAL BOARD: silicone glass base bakelite; 30 terminals, miniature hollow swaged type, silver plated; without barriers; over-all dim 4 5/8" lg x 1 1/4" wide x 13/16" high, including terminals and standoffs; mtd by two dural aluminum clinch standoffs, threaded for no. 6-32 screws on 3 1/8" centers; mfr CCI, Dwg nos. 326-R-223, 326-R-612	IF chassis terminal board
TB203	Shop manufacture	TERMINAL BOARD: silicone glass base bakelite; 22 terminals, miniature hollow swaged type, silver plated; without barriers; over-all dim 3 3/8" lg x 1 1/16" wide x 13/16" high, including terminals and standoffs; mtd by two dural aluminum clinch standoffs; threaded for no. 6-32 screws on 2 1/2" centers; mfr CCI, Dwg nos. 326-R-222, 326-R-611	IF chassis terminal board
TB204	Shop manufacture	TERMINAL BOARD: silicone glass base bakelite; 22 terminals, miniature hollow swaged type, silver plated; without barriers; over-all dim 3 3/8" lg x 1 1/16" wide x 13/16" high, including terminals and standoffs; mtd by two dural aluminum clinch standoffs; threaded for no. 6-32 screws on 2 1/2" centers; mfr CCI, Dwg nos. 326-R-222, 326-R-610	IF chassis terminal board
TB301	Shop manufacture	TERMINAL BOARD: silicone glass base bakelite; 4 terminals, 3 of clinch standoff type with 6-32 Phillips truss head machine screws, 1 of clinch standoff type with 6-32 Phillips truss head machine screw and jumper bar (center terminal); terminal standoffs brass, silver plated; over-all dim 2 1/4" lg x 1 1/8" wide x 11/16" high, excluding screws and solder lugs; mtd by two no. 25 drill holes on 1 3/4" mtg centers; 3 terminals marked "105", "115", and "125", center terminal marked "C"; solder lugs attached under terminals; mfr CCI, Dwg nos. 327-R-E-205, 327-R-E-212, 327-R-E-617	Audio/Power supply chassis terminal board; AC input switching
TB302	Shop manufacture	TERMINAL BOARD: silicone glass base bakelite; 26 terminals, miniature hollow swaged type, silver plated; without barriers; over-all dim 4 1/16" lg x 1 3/8" wide x 13/16" high, including terminals and standoffs; mtd by wto dural aluminum clinch standoffs, threaded for no. 6-32 screws on 1 1/8" mtg centers; mfr CCI, Dwg nos. 326-R-234, 326-R-618	Audio/Power supply chassis treminal board

TABLE 8-2. TABLE OF REPLACEABLE PARTS

REFERENCE DESIGNATION	STOCK NUMBERS STANDARD NAVY	NAME AND DESCRIPTION	LOCATING FUNCTIONS
TB303	Shop manufacture	TERMINAL BOARD. silicone glass base bakelite; 16 terminals, miniature hollow swaged type, silver plated; without barriers; over-all dim 2 1/2" lg x 1 5/16" wide x 13/16" high, including terminals and standoffs; mtd by two dural aluminum clinch standoffs, threaded for no. 6-32 screws on 1 1/8" mtg centers; mfr CCI, Dwg nos. 326-R-235, 326-R-619	Audio/Power supply chassis terminal board
TB401	Shop manufacture	TERMINAL BOARD: silicone glass base bakelite; 8 terminals, miniature hollow swaged type, silver plated; without barriers; over-all dim 1 5/16" lg x 1" wide x 13/16" high, including terminals and standoffs, mtd by two dural aluminum clinch standoffs, threaded for no. 6-32 screws on 5/8" mtg centers; mfr CCI, Dwg nos. 326-R-233, 326-R-617	Control Panel terminal board
V101	N16-T075749-0000	ELECTRON TUBE: remote cutoff pentode; T-5 1/2 glass envelope; miniature button 7-pin base; "Reliable Type"; per Spec MIL-E-1B, Type 5749/6BA6W; used with E101, XV101	RF amplifier
V102	N16-T056203-0053	ELECTRON TUBE: sharp cutoff pentode; T-5 1/2, glass envelope; miniature button, 7-pin base; "Reliable Type"; per Spec MIL-E-1B, Type 6136/6AU6WA; used with E102, XV102	Channel determining oscillator
V103	N16-T075654-0000	ELECTRON TUBE: RF pentode, sharp cutoff; T-5 1/2, glass envelope; miniature button 7-pin base; "Reliable Type"; per Spec MIL-E-1B, Type 5654/6AK5W; used with E103, XV103	1st mixer
V104		Same as V102; used with E104, XV104	1900 Ks oscillator
V201		Same as V101; used with E201, XV201	2nd mixer
V202		Same as V101; used with E202, XV202	1st 120 Kc IF
V203		Same as V102; used with E203, XV203	2nd 120 Kc IF
V204	N16-T056203-0060	ELECTRON TUBE: duplex diode, high mu triode; T-5 1/2, glass envelope; miniature button 7-pin base; per Spec MIL-E-1B, Type 6AV6; used with E204, XV204	Det-AGC
V205	N16-T075726-0000	ELECTRON TUBE: twin diode; T-5 1/2, glass envelope; miniature button 7-pin base; "Reliable Type"; per Spec MIL-E-1B, Type 5726/6AL5W; used with E205, XV205	Noise limiter-squelch diode
V206	N16-T058240-0014	ELECTRON TUBE: twin triode; T-6 1/2, glass envelope; miniature button 9-pin base; "Reliable Type"; per Spec MIL-E-1B, Type 6201/12AT7WA; used with E206, XV206	1st audio-squelch
V207		Same as V206; used with E207, XV207	BFO-BFO control
V208		Same as V101; used with E208, XV208	BFO-buffer
V301		Same as V204; used with E301, XV301	2nd audio amplifier
V302	N16-T076005-0000	ELECTRON TUBE: beam-power amplifier; T-5 1/2, glass envelope; miniature button 7-pin base; "Reliable Type"; per Spec MIL-E-1B Type 6005/6AQ5W; used with E302, XV302	Audio output
V303		Same as V206; used with E303, XV303	Audio limiter

W601	Assemble from component parts	CABLE ASSEMBLY, SPECIAL PURPOSE: five conductor, in vinylite tubing; terminating at each end in 10-pin connectors; over-all length 6′ 0″; mfr CCI, Dwg no. 327-R-E-402; consists of: E601, E602, P601, P602, W601A	Test cable, complete
W601A	Assemble from component parts	CABLE, SPECIAL PURPOSE, ELECTRICAL: total of 5 conductors; length of each conductor 5′ 7″; 2 conductors of JAN-C-76, Type SRIR wire, #22 stranded (7), with shielding braid and over-all outer vinylite jacket (shielding braid to be used as ground conductor); 2 conductors of JAN-C-76, Type SRIR wire, #18 stranded (7), grey color code; 1 conductor of RG-58A/U coaxial cable, black; mfr CCI, Dwg no. 327-R-E-402; p/o W601	Part of test cable
XC301	For replacement use SNSN N16-S063515-4162	SOCKET, ELECTRON TUBE: octal; per Spec JAN-S-28A, Type TS101P01; used with C305	C305 socket
XC302		Same as XC301; used with C306	C306 socket
XF301	N17-F074266-9053	FUSEHOLDER: extractor post type; 15 amp, 250 v rating; accommodates one type 3AG glass cartridge fuse, 1/4″ dia x 1 1/4″ lg; black bakelite body; over-all dim 1 11/16″ lg x 11/16″ dia, excluding terminal; 2 solder lug terminals; single hole mtg, 1/2″ dia; bayonet type knob permits fuse removal with 1/4 turn; mfr CLF, Type B-342003; used with F301	F301 fuse holder
XF302		Same as XF301; used with F302	F302 fuse holder
XI201	N17-L051710-3691	LAMPHOLDER: for use with double contact, bayonet candelabra base lamp; plastic body; nickel plated brass shell; 1 1/16″ lg x 1 1/2″ wide x 1 1/16″ high overall; mounted by two 5/32″ dia holes on 1 3/16″ centers, on horizontal surface; mounting hole centers above base of socket; mfr Frank B. Morse Co., part no. 231-DC; modified per CCI dwg 326-R-259, for use with I201	Lampholder for I201
XI202		Same as XI201; used with I202	Lampholder for I202
XI401	N17-L076773-5476	LIGHT, INDICATOR: miniature; plain white jewel, stovepipe shape; bayonet base, accommodates T-3 1/4, Type NE-51 lamp; rated at 125 volts; mfr, CAYZ; Type LH64PW5, per Spec MIL-L-3661; DIALCO 95408-935; used with I401	Pilot light lamp holder
XV101	For replacement use SNSN N16-S062603-6700	SOCKET, ELECTRON TUBE: miniature; 7 contacts; Type TS102P01; per Spec JAN-S-28A, used with V101	V101 tube socket
XV102		Same as XV101; used with V102	V102 tube socket
XV103		Same as XV101; used with V103	V103 tube socket
XV104		Same as XV101; used with V104	V104 tube socket
XV201		Same as XV101; used with V201	V201 tube socket
XV202		Same as XV101; used with V202	V202 tube socket
XV203		Same as XV101; used with V203	V203 tube socket
XV204		Same as XV101; used with V204	V204 tube socket
XV205		Same as XV101; used with V205	V205 tube socket
XV206	N16-S064063-6713	SOCKET, ELECTRON TUBE: miniature; 9 contacts; Type TS103P01, per Spec JAN-S-28A; used with V206	V206 tube socket

TABLE 8-2. TABLE OF REPLACEABLE PARTS

REFERENCE DESIGNATION	STOCK NUMBERS STANDARD NAVY	NAME AND DESCRIPTION	LOCATING FUNCTIONS
XV207		Same as XV206; used with V207	V207 tube socket
XV208		Same as XV101; used with V208	V208 tube socket
XV301		Same as XV101; used with V301	V301 tube socket
XV302		Same as XV101; used with V302	V302 tube socket
XV303		Same as XV206; used with V303	V303 tube socket
XY101	N16-S054284-7281	SOCKET, CRYSTAL: two 0.050″ dia pins accommodated, spaced 1/2″ C to C; rectangular with rounded ends; over-all dim excluding terminals 25/32″ lg x 5/16″ wide x 5/16″ high; ceramic body; top screw mtg; mtd by one 1/8″ hole, spaced midway between contacts; mfr CJA, Type 33302; used with Y101	Channel determining crystal socket
XY102		Same as XY101; used with Y102	1900 Kc oscillator crystal socket
Y101	For reference only	CRYSTAL UNIT, QUARTZ: one crystal plate; nominal frequency between 6,990 Kc and 14,990 Kc; Type CR-18/U, per Spec MIL-C-3098; used with XY101	Channel Determining Crystal
Y102	N16-C099402-1007	CRYSTAL UNIT, QUARTZ: one crystal plate; nominal frequency 1,900 Kc; CR-18/U, per Spec MIL-C-3098; used with XY102	1900 Kc crystal
Z101	N16-T098088-5614	TUNING UNIT, RADIO FREQUENCY: frequency range 8-32 Mc in 3 bands Band I: 8-16 Mc, Band II: 16-24 Mc, Band III: 24-32 Mc), switched through switch deck enclosed in shield can, shaft screwdriver turned from rear of chassis; adjustable tuning with 7.5-99 $\mu\mu$f trimmer capacitor, screwdriver tuned; includes fixed padder capacitor 7 $\mu\mu$f and fixed series capacitors 75 $\mu\mu$f, 36$\mu\mu$f; shielded; etched aluminum shield can, retained by two no. 4-40 x1/4″ Phillips type captive screws; approx calebration settings in Mc silk screened on top of shield can; over-all dim 2 7/16″ lg x 1 31/32″ wide x 2 15/16″ high, excluding terminals and turning screw; mtd by two spade bolts no. 6-32 x 3/8″ lg on 1 9/16″ mtg centers; 6 minature hollow swaged terminals located on bottom; mfr CCI, Dwg no. 331-R-302; consists of L101, L102, L103, C101, C102, C103, C127, E106(A); used with S101	1st RF tuning unit
Z102	N16-T098088-5616	TUNING UNIT, RADIO FREQUENCY: frequency range 8-32 Mc in 3 bands (Band I: 8-16 Mc, Band II: 16-24 Mc, Band III: 24-32 Mc), switched through switch deck enclosed in shield can, shaft screwdriver turned from rear of chassis; adjustable tuning with 7.5-99 $\mu\mu$f trimmer capacitor, screwdriver tuned; includes 2 fixed series capacitors of 75 $\mu\mu$f, 36 $\mu\mu$f, and 2 fixed bottom coupling capacitors of 0.01 μf and 0.02 μf; shielded, etched aluminum shield can, retained by two no. 4-40 x 1/4″ Phillips type captive screws; approximate calibration settings in Mc silk screened on top of shield can; over-all dim 2 7/16″ lg x 1 31/32″ wide x 2 15/16″ high, excluding terminals and tuning screw; mtd by two spade bolts no. 6-32 x 3/8″ lg on 1 9/16″ mtg centers; 6 miniature hollow swaged terminals located on bottom; mfr CCI. Dwg no. 331-R-303; consists of L104, L105, L106, C106, C108, C109, C110, C118, E106(B); used with S101	2nd RF tuning unit

Z103	N16-T098088-5615	TUNING UNIT, RADIO FREQUENCY: frequency range 8-32 Mc in 3 bands (Band I: 8-16 Mc, Band II: 16-24 Mc, Band III, 24-32 Mc), switched through switch deck enclosed in shield can, shaft screwdriver tuned from rear of chassis; adjustable tuning with 7.5-99 $\mu\mu$f trimmer capacitor, screwdriver tuned; includes 2 fixed series capacitors of 75 $\mu\mu$f, 39 $\mu\mu$f; shielded; etched aluminum shield can, retained by two no. 4-40 x 1/4" Phillips type captive screws; approximate calibration settings in Mc silk screened on top of shield can; over-all dim 2 7/16" lg x 1 31/32" wide x 2 15/16" high, excluding terminals and tuning screw; mtd by two spade bolts no 6-32 x 3/8" lg on 1 9/16" mtg centers; 6 miniature hollow swaged terminals located on bottom; mfr CCI, Dwg no. 331-R-304; consists of L107, L108, L109, C115, C116, C117, E106(C); used with S101	3rd RF tuning unit
Z104	N16-T098088-5617	TUNING UNIT, RADIO FREQUENCY: frequency range 8-32 Mc in 3 bands (Band I: 8-16 Mc, Band II: 16-24 Mc, Band III: 24-32 Mc), switched through switch deck enclosed in sheild can, shaft screwdriver turned from rear of chassis; adjustable tuning with 7.5-99 $\mu\mu$f trimmer capacitor, screwdriver tuned; includes 2 fixed series capacitors of 75 $\mu\mu$f, 43 $\mu\mu$f, and 2 fixed bottom coupling capacitors of 0.01 μf and 0.02 μf; shielded; etched aluminum shield can, retained by two no. 4-40 x 1/4" Phillips type captive screws; approximate calibration settings in Mc silk screened on top of shield can; over-all dim 2 7/16" lg x 1 31/32" wide x 2 15/16" high, excluding terminals and tuning screw; mtd by two spade bolts no. 6-32 x 3/8" lg on 1 9/16" mtg centers; 6 miniature hollow swaged terminals located on bottom; mfr CCI, Dwg no. 331-R-305; consists of L110, L111, L112, C120, C121, C122, C146, C147, E106(D); used with S101	4th RF tuning unit

TABLE 8-3. CROSS REFERENCE PARTS

* For replacement use

JAN or MIL DESIGNATION	KEY SYMBOL	JAN or MIL DESIGNATION	KEY SYMBOL	JAN or MIL DESIGNATION	KEY SYMBOL
MIL-E-1B		RC20BF564K	R119	TS103P01	XV206
6AV6	V204	RC20BF680K	R102	TS102U01	E103
5654/6AK5W	V103	RC20BF683J	R219	TS102U02	E101
5726/6AL5W	V205	*RC20GF101J	R203	TS103U02	E206
5749/6BA6W	V101	*RC20GF103J	R116		
6005/6AQ5W	V302	*RC20GF104J	R101	JAN-C-62	
6136/6AU6WA	V102	*RC20GF105J	R109	CE53B600J	C306
6201/12AT7WA	V206	*RC20GF152J	R223	CE53F100R	C305
		*RC20GF155J	R117	CE63C150K	C303
MIL-C-5A		*RC20GF184J	R302		
CM20B100K	C148	*RC20GF222J	R104	MIL-C-71A	
CM20B471K	C310	*RC20GF222J	R232	UG-58A/U	J501
CM20C101J	C137	*RC20GF223J	R107	UG-21B/U	P501
CM20C360J	C102	*RC20GF224J	R113	UG-177/U	E501
CM20C390J	C109	*RC20GF225J	R313		
CM20C430J	C121	*RC20GF272J	R402	JAN-C-92	
CM20C470J	C123	*RC20GF273J	R103	CT1C100	C103
CM20C680J	C219	*RC20GF332J	R108		
CM20C750J	C101	*RC20GF334J	R239	JAN-R-94A	
CM20C820J	C138	*RC20GF393J	R401	RV4ATSA104A	R114
CM20D271J	C234	*RC20GF471J	R105	RV4ATSC503A	R405
CM20D331J	C201	*RC20GF472J	R106	RV4ATSC503E	R217
CM30B122K	C105	*RC20GF473J	R310	*RV4ATSD503A	R405
*CM30E122J	C105	*RC20GF474J	R224	JAN-J-641	
CM35B472K	C309	*RC20GF680J	R102	JJ-034	J404
CM35C103K	C118	*RC20GF683J	R219		
*CM35E103J	C118	RC30BF223K	R202	MIL-F-15160C	
		RC30BF333K	R220	FO2G1R00B	F301
MIL-R-11B		RC30BF473K	R225		
RC20BF101K	R203	RC30GF562K	R306	MIL-L-15098	
RC20BF102K	R210	*RC32GF223J	R202	VG-8	I201
RC20BF103K	R116	*RC32GF333J	R220		
RC20BF104K	R101	*RC32GF473J	R225	MIL-C-3661	
RC20BF105K	R109	*RC32GF562J	R306	LH64PW5	XI401
RC20BF152K	R223				
RC20BF154K	R211	JAN-C-20A		MIL-C-3608	
RC20BF155K	R117	CC20CJ030C	C124	*UG-88C/U	P301
RC20BF184K	R302	CC20CK010C	C133	UG-88/U	P301
RC20BF222J	R232	CC20CK020C	C142	*UG-290A/U	J102
RC20BF222K	R104	CC20CK040C	C217	UG-290/U	J102
RC20BF223K	R107	*CC20PH120G	C210		
RC20BF224K	R113	CC20PJ120J	C210	MIL-C-5015	
RC20BF225K	R313			AN3102A-10SL-3P	J503
RC20BF272K	R402	JAN-S-23		AN2102A-10SL-4P	J502
RC20BF273K	R103	ST42A	S202	AN2106A-10SL-3S	P503
RC20BF332K	R108	ST52K	S401	AN2106A-10SL-4S	P502
RC20BF334K	R239				
RC20BF392K	R118	MIL-R-26B		MIL-C-3098A	
RC20BF393K	R401	RW20G502	R307	CR-18/U	Y101
RC20BF471K	R105			CR-18/U	Y102
RC20BF472K	R224	JAN-S-28A			
RC20BF473K	R106	TS101P01	XC301		
RC20BF474K	R310	TS102P01	XV101		

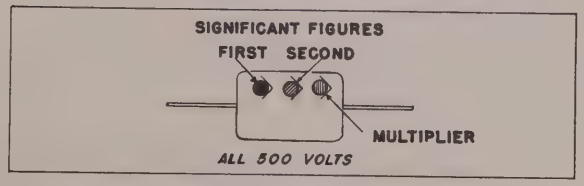
TABLE 8-3. CROSS REFERENCE PARTS

* For Replacement Use

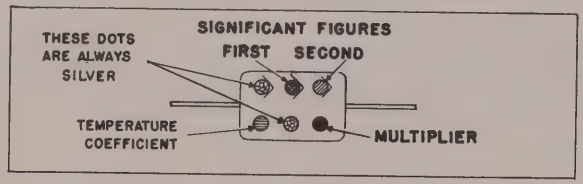
STANDARD NAVY STOCK NUMBER	KEY SYMBOL	STANDARD NAVY STOCK NUMBER	KEY SYMBOL	STANDARD NAVY STOCK NUMBER	KEY SYMBOL
G5920-280-4465	F301	*N16-R050038-0438	R402	N16-S064-063-6713	XV206
G6240-179-1813	I201	N16-R050039-0811	R402	N16-T056203-0053	V102
G6240-223-9100	I401	*N16-R050065-0438	R108	N16-T056203-0060	V204
N16-A039380-2136	AR201	N16-R050066-0811	R108	N16-T058240-0014	V206
N16-A039380-2140	AR101	*N16-R050092-0438	R118	N16-T075654-0000	V103
N16-A039390-6175	AR301	N16-R050093-0811	R118	N16-T075726-0000	V205
N16-C015368-5828	C133	N16-R050129-0811	R224	N16-T075749-0000	V101
N16-C015432-5828	C142	*N16-R050164-0761	R306	N16-T076005-0000	V302
N16-C015528-5428	C124	N16-R050166-0238	R306	N16-T098088-5614	Z101
*N16-C015560-4628	C217	*N16-R050281-0438	R116	N16-T098088-5615	Z103
*N16-C015949-1994	C210	N16-R050282-0811	R116	N16-T098088-5615	Z102
N16-C018659-8953	C114	*N16-R050371-0433	R107	N16-T098088-5617	Z104
N16-C018661-1302	C224	*N16-R050371-0711	R202	N17-C070319-1800	P502
N16-C019140-9551	C107	N16-R050372-0811	R107	N17-C070326-9330	P503
N16-C019143-3852	C106	N16-R050373-0231	R202	*N17-C071408-9255	P301
N16-C019143-7839	C104	*N16-R050398-0131	R103	*N17-C071417-9699	P501
N16-C019639-7726	C303	N16-R050399-0811	R103	N17-C072595-1800	J502
N16-C022489-5051	C305	*N16-R050416-0682	R220	N17-C072602-9330	J503
*N16-C022799-4015	C306	N16-R050418-0231	R220	N17-C073108-1267	J102
N16-C025513-6245	C127	*N16-R050443-0438	R401	*N17-C073108-2878	J102
N16-C026025-8276	C148	N16-R050444-0811	R401	N17-C073108-5906	J501
*N16-C026938-8321	C145	*N16-R050479-0435	R106	N17-C073285-6012	J504
N16-C026943-9811	C145	*N16-R050479-0713	R225	N17-C073323-3220	J401
N16-C027181-4401	C116	N16-R050480-0811	R106	N17-C073569-8951	J302
N16-C027286-9001	C102	N16-R050481-0231	R225	N17-C073615-4692	J101
N16-C027366-1201	C109	*N16-R050551-0401	R219	N17-F074266-9053	XF301
N16-C027471-5801	C121	N16-R050551-0431	R219	N17-J039248-4418	J404
N16-C027577-1401	C123	*N16-R050632-0416	R101	N17-L051710-3691	XI201
N16-C027999-1801	C219	N16-R050633-0811	R101	N17-L076773-5476	XI401
N16-C028130-9801	C101	*N16-R050677-0380	R211	N17-R051401-8474	CR303
N16-C028210-2001	C138	N16-R050678-0811	R211	N17-R051504-1001	CR301
N16-C028553-1201	C137	*N16-R050695-0436	R302	N17-S034557-8351	E101
N16-C029608-2206	C234	N16-R050696-0811	R302	N17-S056611-5507	S402
N16-C029713-6806	C201	*N16-R050713-0380	R113	N17-S061714-4581	S403
*N16-C030109-3806	C310	N16-R050714-0811	R113	N17-S064718-5471	S301
N16-C030114-4726	C310	*N16-R050758-0377	R239	N17-S065193-5687	S201
*N16-C031269-9556	C105	N16-R050759-0811	R239	N17-S070412-4406	S202
N16-C031274-9964	C105	*N16-R050821-0276	R310	N17-S072828-2605	S401
*N16-C032641-6338	C309	N16-R050822-0811	R310	N17-S250051-0153	E501
N16-C032646-6807	C309	*N16-R050857-0438	R119	N17-T064535-9171	T302
*N16-C033617-4758	C118	N16-R050858-0811	R119	N17-T067468-3747	T201
N16-C033622-5227	C118	*N16-R050974-0438	R109	N17-T067468-3748	T204
N16-C060528-2545	C103	N16-R050975-0811	R109	N17-T068397-8361	T101
N16-C072745-1875	L503	*N16-R051019-0440	R117	N17-T073688-3591	T301
N16-C074484-9020	L501	N16-R051020-0811	R117	N17-T081354-9385	T205
N16-C076791-9343	L401	*N16-R051064-0435	R313		
N16-C099402-1007	Y102	N16-R051065-0811	R313		
N16-F032120-1751	FL301	*N16-R066251-3269	R307		
N16-R029236-8021	L301	N16-R085010-4433	R201		
*N16-R049498-0438	R102	N16-R087849-4746	R217		
N16-R049499-0811	R102	*N16-R087849-4757	R405		
*N16-R049579-0131	R203	N16-R087850-7049	R405		
*N16-R049768-0438	R105	*N16-R088009-4010	R114		
*N16-R050011-0438	R104	N16-R089071-3405	R301		
N16-R049580-0811	R203	N16-S034520-3862	E103		
N16-R049769-0811	R105	N16-S034557-9351	E101		
N16-R049922-0811	R210	N16-S034576-6513	E206		
*N16-R049966-0433	R223	N16-S034503-6631	E302		
N16-R049967-0811	R223	N16-S054284-7281	XY101		
N16-R050011-0431	R232	*N16-S062603-6700	XV101		
*N16-R050011-0438	R232	N16-S062603-6702	XV101		
*N16-R050012-0811	R104	*N16-S063513-4162	XC301		
*N16-R050128-0438	R224	N16-S063515-4151	XC301		

CAPACITOR COLOR CODES

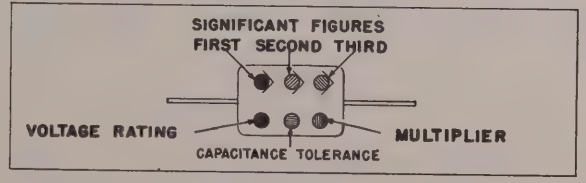
RMA 3-DOT CODE - FOR MICA-DIELECTRIC CAPACITORS



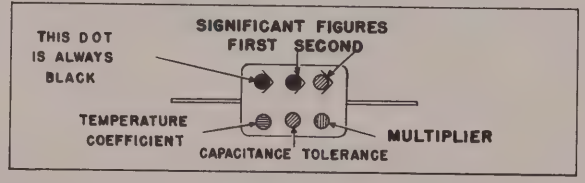
JAN 6-DOT CODE - FOR PAPER-DIELECTRIC CAPACITORS



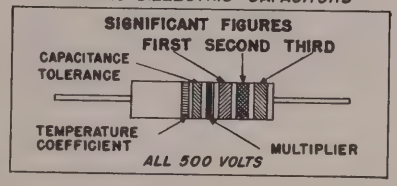
RMA 6-DOT CODE - FOR MICA-DIELECTRIC CAPACITORS



JAN 6-DOT CODE - FOR MICA-DIELECTRIC CAPACITORS



RMA COLOR CODE FOR TUBULAR CERAMIC-DIELECTRIC CAPACITORS



JAN COLOR CODE FOR FIXED CERAMIC-DIELECTRIC CAPACITORS

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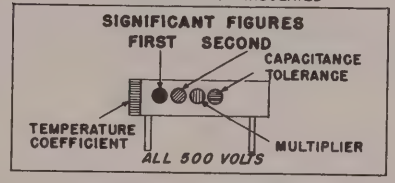
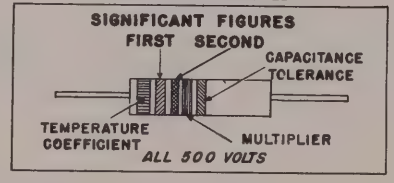


AXIAL TYPE INSULATED



RMA: RADIO MANUFACTURERS ASSOCIATION
JAN: JOINT ARMY-NAVY

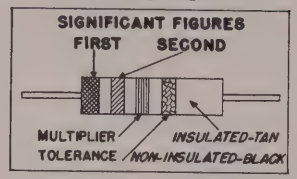
RESISTORS				CAPACITORS				
				MULTIPLIER				
TOLERANCE	MULTIPLIER	SIGNIFICANT FIGURE	COLOR	RMA MICA AND CERAMIC-DIELECTRIC	JAN MICA AND PAPER-DIELECTRIC	JAN CERAMIC DIELECTRIC	VOLTAGE RATING	TEMPERATURE COEFFICIENT
	1	0	BLACK	1	1	1		A
	10	1	BROWN	10	10	10	100	B
	100	2	RED	100	100	100	200	C
	1,000	3	ORANGE	1,000	1,000	1,000	300	D
	10,000	4	YELLOW	10,000			400	E
	100,000	5	GREEN	100,000			500	F
	1,000,000	6	BLUE	1,000,000			600	G
	10,000,000	7	VIOLET	10,000,000			700	
	100,000,000	8	GRAY	100,000,000		0.01	800	
	1,000,000,000	9	WHITE	1,000,000,000		0.1	900	
5	0.1		GOLD	0.1	0.1		1000	
10	0.01		SILVER	0.01			2000	
20			NO COLOR				500	

TABLE 8-4. APPLICABLE COLOR CODES AND MISCELLANEOUS DATA

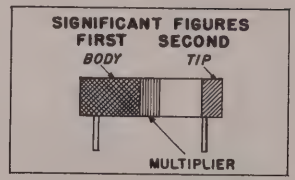
RESISTOR COLOR CODES

RMA COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE

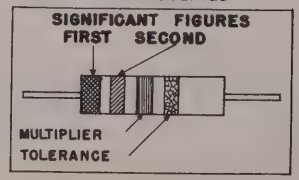


RADIAL TYPE



JAN COLOR CODE FOR FIXED COMPOSITION RESISTORS

AXIAL TYPE INSULATED



RADIAL TYPE NON-INSULATED

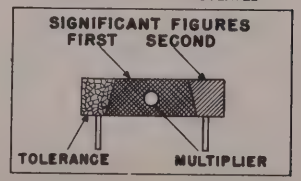


TABLE 8-5. LIST OF MANUFACTURERS

CODE NUMBER	PREFIX	NAME	ADDRESS
1	CPH	American Phenolic Corp.	1830 South 54th Ave., Chicago, Ill.
2	CUD	Audio Development Co.	28-33 13th Ave., Minneapolis, Minn.
3	CED	Cannon Electric Development Co.	3209 Humboldt St., Los Angeles, Calif.
4	CCO	Carborundum Co., Globar Div.	C. P. Knupfer Bldg. Niagara Falls, N.Y.
5	CBN	Central Radio Laboratory	900 E. Keefe Ave., Milwaukee, Wis.
6	CTC	Chicago Telephone Supply Co.	Elkhart, Ill.
7	CCI	Communications Company, Inc.	300 Greco Ave., Coral Gables, Florida
8	CAYZ	Dial Light Corp.	900 Broadway New York, N.Y.
9	CAVT	Elco Corp.	114 W. 18th Street New York, N.Y.
10	CG	General Electric Co.	200 Main St., Clifton, N. J.
11	CBDW	Grayhill	561 Hillgrove Ave., La Grange, Ill.
12	CLF	Littlefuse Laboratories, Inc.	1865 Miner St., Desplaines, Ill.
13	CJA	Millen Co., James	150 Exchange St., Malden, Mass.
14		Morse, Frank W., Co.	1300 Soldiers Field Road Boston 35, Mass.
15	CBJS	Radio Materials Corp.	3325 N. California Ave., Chicago 18, Ill.
16	CBGB	Sarkes Tarzian	415 N. College Avenue Bloomington, Ind.
17	CSA	Stackpole Carbon Co.	201 Tannery St., St. Mary's, Pa.
18	CADF	Standard Transformer Corp.	1500 N. Elston, Chicago, Ill.
19		Wilco Corp.	546 Drover St., Indianapolis 21, Indiana

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